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A Quarterly Journal for
Teachers of Science in
the Catholic High Schools

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Ode To Science

• **By Sister Mary Basilia, O.S.P.**
ST. ROBERT'S SCHOOL, MILWAUKEE, WISCONSIN

I

I walked beside the road and saw a rose
Pinkpetaled, fragrant loveliness;
But Science showed its myriad parts in unity,
Within the nucleus, life's mystery,
Epic of roses past and roses yet to be.

II

I went into the woods and saw the fir
Refreshing in its cool green color,
Spired symmetry;
But Science helped my eyes once more
And showed to me the cone and megaspore.

III

I came into a glade and saw the fern
Its graceful leaves in Gothic arches turn
A rythmic study;
But Science showed the heart-prothallium.
A secret message was conveyed to me,—
Life cycles planned from out eternity.

IV

I watched beside a lake and saw
A scum upon its shore
And liked it not;
A miracle I saw with lenses fixed,
The slender filament of the Ulothrix.

V

If you can lift my soul
From depth of slime
To contemplate the Infinite sublime,
Then with the Royal Psalmist I'll proclaim
In all God's works how mighty is His Name.

A SOUND GUIDE TO ECONOMY IN THE PURCHASE OF LABORATORY WARE

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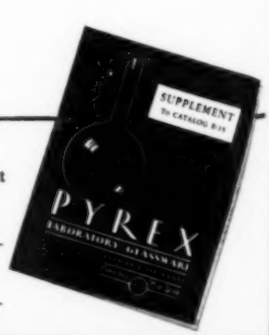

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Three Cordial Invitations . . .

To a Science Conference
To a National Essay Contest
To an Exhibit of Science Projects

●

SCIENCE CONFERENCE

On Saturday, February 19, 1938, Duquesne University will hold its sixth annual one-day Conference for teachers of science in Catholic High Schools everywhere. To this meeting, science teachers, scientists, school administrators, school executives, and all others who are interested in improving instruction in science in the Catholic secondary schools, are cordially invited. The invitation is all-inclusive. Teachers from Portland will be as welcome as teachers from Pittsburgh. Special invitations will be extended neither to individuals nor to schools. This is the only formal announcement of the conference that will be made. *This is your invitation.* Although the invitation must necessarily be anonymous, it is both cordial and sincere.

When the conferences were begun in 1932, they were designed, modestly, for the teachers of science in the local high schools only. As the good derived from the earlier meetings became more clearly apparent, teachers began to come from a wider and wider area until, in 1937, groups of teaching sisters journeyed several hundred miles to attend.

The purpose of the yearly meetings is well defined. It is to help teachers of science to keep up-to-date scientifically and pedagogically. The conferences afford opportunities for meeting scientists, teachers, and executives who are outstanding in their fields. To those teachers who have few scientific contacts, they offer the stimulation and inspiration that come from meeting new and fresh minds. The study of mutual problems with others of similar interests, the clarification of ideas by means of thorough and thoughtful discussion, the examination of new methods and new procedures with which other teachers are producing good results, the learning at first-hand what other teachers are doing in the development and use of modern methods—all these are helpful and salutary. The friendly social contacts that are made are very pleasant.

Every minute of the conference day will be full. The morning hours will be occupied by a general session that will be addressed by the Most Reverend Hugh C. Boyle, Bishop of Pittsburgh. Each year Bishop Boyle has shown his interest by a gracious and encouraging address to the group and a careful study of the science project material on display. Rev. Paul E. Campbell, Superintendent of Parish Schools of the Diocese of Pittsburgh, and the Very Reverend J. J. Callahan, C. S. Sp., President of Duquesne University, will welcome the visiting teachers. Hugh C. Muldoon, director of the conference, will preside.

One of the main addresses at the morning session will be given by Sister Mary Ellen O'Hanlon, Ph. D., professor of biology at Rosary College, River Forest, Ill. With Rev. U. A. Hauber of St. Ambrose College, Sister Mary Ellen is co-author of a recently published college textbook of biology, which is attracting much favorable attention. Other important addresses will be made by Dr. James N. Rule, former state superintendent of public instruction of Pennsylvania, and by Howard J. Leahy, of the department of psychology of Duquesne University.

After a noon luncheon, at which all in attendance will be guests of the University, demonstrations in the separate sciences will be given by Sisters who are active in their special fields. Three round table discussions dealing with the problems and methods of physics, chemistry, and biology will follow. They will be led by other teaching Sisters.

During the day the result of the national science essay contest will be announced. A display of student science project material, submitted by Catholic high schools all over the country, will be on exhibition. The loan of material for this exhibition is requested in another place in this issue.

There is no registration fee or charge of any kind in connection with the Conference. Visiting teachers will be cared for by the Sisters' Alumnae of Duquesne University under the leadership of Sister M. Aurelia Arenth, O.S.F., President. Members of the Sisters' Alumnae will act as hostesses and guides. They will serve tea during the social hour that concludes the program for the day.

The Sisters' Alumnae will provide accommodations for all visiting Sisters. Reservations may be made by addressing Sister M. Aurelia Arenth at St. Wendelin's Convent, Custer avenue, Pittsburgh. A large number of teachers will be in attendance. Those who come from considerable distances will find it desirable to make reservations well in advance of the Conference. When the time of arrival is specified, Sisters will be met at trains and conducted to the convents to which they have been assigned.

SCIENCE ESSAY CONTEST

The first national essay contest, conducted in connection with the 1937 Conference, attracted entries from high schools all over the United States. So successful was it, that it is to be repeated in 1938. All Catholic

high schools which teach any of the sciences are invited to participate by submitting *one* student essay on the assigned topic. Progressive teachers will use this contest to stimulate student interest in science. In order that the greatest good may result from this competition, it is suggested that the essays submitted in the national contest should be selected by means of contests in the individual schools.

Teachers are not to expect individual invitations for their schools. *This is an official invitation to all Catholic high schools to enter this contest.* It is an invitation to *your* school. No further announcement of the contest will be made.

The essays submitted in this competition will be judged by members of the faculty of Duquesne University. Form, content, and expression will be considered. A gold medal, for permanent possession, will be awarded to the writer of the best essay. One or more honorable mentions will be made, depending upon the excellence of the essays submitted. A suitably engraved silver cup will be given to the winning school. The cup will be held for one year. It will then be passed on to the school receiving the new award. This cup is now in the possession of St. Charles High School, Waltham, Mass., the school which won the 1937 contest.

Announcement of the winner will be made at the next annual Conference for teachers of science which will be held at Duquesne University on February 19, 1938. The prize essay will be published in full in the SCIENCE COUNSELOR. Only winning essays and schools will be announced. A list of the schools which enter the contest will not be published.

Schools which expect to submit essays in this contest should so inform the Director of the Science Conference, Duquesne University, Pittsburgh, Pa., by letter or postcard, on or before January 1, 1938. No obligation is incurred by sending such notice.

The rules which are to govern the contest are here given.

RULES FOR ESSAY CONTEST

Subject of the Essay: *Science in the Laundry.* No other subject may be used.

1. Any student enrolled in a Catholic high school, junior high school, or preparatory school, who has not yet completed four years of high school work, is eligible to enter this contest. It is not required that the student shall be enrolled at present in any science course. Catholic students attending public high schools may not compete.
2. Each school may submit *only one* essay.
3. Essays should be typewritten, double-spaced, with good margins, on one side of the sheet only. Legible hand-written manuscripts may be accepted. Essays are to be in essay form. They may not exceed 1,200 words in length. Longer essays will be rejected without reading. All direct quotations must be inclosed in quotation marks and references given. Long quotations are not acceptable. Essays may not be illustrated nor accompanied by charts or exhibits.
4. Each essay shall be the individual work of the student. In its final form it may receive only such supervision as is given in the usual written examinations of the school.
5. A plain, sealed envelope, firmly attached to the essay, must contain the full name, age, and home address of the contestant, the actual number of words in the essay, the name and address of the school, and the name and title of the supervising teacher. No further identification of the writer or the school may appear on the essay or the envelope.
6. Essays must be forwarded by the principal or the supervising teacher with the statement that the essay was written under supervision and that it is the original work of the student.
7. Essays for this contest must be mailed to the Director of the Science Conference, Duquesne University, Pittsburgh, Pa., not later than *February 1, 1938.* Essays will not be returned.

SCIENCE PROJECTS

Teachers are always interested in the work done and the teaching methods employed by instructors in other schools. Teachers of science may be greatly aided by studying the student projects that have been found workable and useful by other teachers. An exchange of ideas is helpful and productive of good. Duquesne University, therefore, invites teachers everywhere to select some of the more successful science project material they have used or developed and submit it for display at the Science Conference on February 19, 1938.

The projects submitted need not be original; neither need they necessarily be elaborate or expensive. They may be in the form of home-made apparatus, collected materials, herbaria, specimens, displays, teaching devices, models, carvings, drawings, photographic work, special charts, etc. They may be connected with any high school science. Displays at other conferences have included everything from models of teeth carved from soap to home-made telescopes; from a collection of butterflies to a series of instructional charts. Pictures of some of these have appeared in the SCIENCE COUNSELOR. Photographs will be made of the most interesting projects displayed at the coming meeting.

Please send in a display even if you are unable to be in attendance. In order to display your projects it is not necessary that you or any member of your science staff shall attend the Conference. Regardless of where your school is located, this is an opportunity for *you* to help others teachers of science. *Will you do it?*

Each display should be labeled with the full name and address of the school, the name of the teacher, and the name of the student. They should be addressed to the Director of the Science Conference, Duquesne University, Pittsburgh, Pa., and shipped so that they will arrive on or before February 12, 1938.

All project material will be returned, carriage paid, to the cooperating schools after the Conference.

ROUND TABLE TOPICS

The Round Table discussions in each of the high school sciences arranged for the annual Science Conference, give teachers an excellent opportunity for discussing the troublesome points that have been bothering them, and for obtaining the opinions of other teachers on procedures and methods. Here they may obtain help in deciding some question which the science staff has discussed but which it has not settled satisfactorily.

Continued on Page One Hundred and Twenty-eight

The Pittsburgh Experiment Station Of The United States Bureau Of Mines[1]

● **H. P. Greenwald**
SUPERVISING ENGINEER, PITTSBURGH EXPERIMENT STATION, U. S. BUREAU OF MINES

Some of the most important investigative work of the United States Bureau of Mines has been done at its Pittsburgh Experiment Station.

This Station has trained 800,000 persons in first aid to the injured. It has instructed more than 50,000 individuals in the use of gas masks and oxygen-breathing apparatus. At this Station the causes and prevention of mine disasters are studied, explosives are tested, and new methods of utilizing coal are sought. Other researches are in progress.

In this article, its Supervising Engineer gives a necessarily brief but interesting account of this great research institution and its work. The accompanying photographs are furnished through the courtesy of the United States Bureau of Mines.

●

The U. S. Bureau of Mines is a technical bureau of the Department of the Interior, created in 1910 by Congressional Act for the purpose of conducting scientific and technologic investigations concerning mining and the preparation of mineral substances with a view to the increase of health, safety, and efficiency in the mineral industries. Its work has two phases: investigative, to determine the best procedure along these lines; and cooperative, to assist industry in utilizing to the fullest practicable degree the improved practices thus developed.

The personnel and facilities for performing these services consist of headquarters at Washington, D. C., with experiment stations, safety stations and field offices situated at strategic places throughout the country, including Alaska. These facilities are supplemented by those of industry, which aids and cooperates with the Bureau in its work.

The Pittsburgh Experiment Station is the largest of the Bureau's stations. Briefly, the work conducted deals principally with (a) the testing and processing of fuels; (b) research and technical investigations pertaining to the cause and prevention of accidents from mine gases, dusts, fires, explosions, explosives, and mechanical equipment with particular emphasis on the use of electricity in mines; (c) instruction of mine officials and miners in first-aid, accident prevention and rescue procedures; and (d) giving rescue and recovery assistance in event of mine fires and explosions.

Figure 1, a rear view of the experiment station, shows the main building in the background, the power house indicated by the two stacks, and a combined warehouse and railroad-car storage building in the foreground. To the right of the picture are garages and a one-story building used in studies of the hydrogenation of coal. The power house also contains metallurgical and fuel-testing laboratories, and the warehouse contains the coal-carbonization laboratory.

The Bureau's experimental coal mine property, located some 14 miles south of Pittsburgh, is administered as a part of the station. Figure 2 is a view of the central portion of this property, which consists of 77 acres of surface, and approximately 35 acres of unmined coal in the Pittsburgh coal bed. The mine portals appear at the center of the picture, and the buildings to the right form the explosives testing station where all physical testing of explosives is done. Buildings to the left of the portals are used in connection with the work in the mine.

The work of the Pittsburgh Station is divided into sections covering the different phases, and these sections are grouped into technical divisions, the headquarters of the division chiefs being principally in Washington. For a brief description it is more convenient to divide the work into phases which cut across division lines to a minor extent.

SAFETY WORK

Safety Section.—The objective of the safety section is the prevention of accidents and the promotion of safety in the mineral industries through instruction and dissemination of data. The work is carried on through publications, classes in accident prevention given to mine employees and officials, training in first-aid to the injured, use and care of oxygen breathing apparatus, and rescue and recovery work in case of disaster. Safety inspection reports of mines are made on request, and disasters are investigated in order to gain information by which their repetition may be prevented.

FIG. 1
PITTSBURGH EXPERIMENT STATION. UNITED STATES BUREAU OF MINES.

[1] Published by permission of the Director, U. S. Bureau of Mines. (Not subject to copyright.)

FIGURE 2
PANORAMA OF EXPERIMENTAL MINE AND EXPLOSIVES TESTING STATION

Over 800,000 persons have been trained in first-aid to the injured, 55,000 in the use and care of oxygen breathing apparatus, and about 6,000 mine officials in accident prevention work.

To a person not thoroughly familiar with the work, training in the use of oxygen breathing apparatus is particularly interesting. A man equipped with this apparatus is able to work for a period of approximately two hours in any atmosphere in which there are no gases or vapors which might irritate his skin or be absorbed through it as a poison. Atmospheres deficient in oxygen and high in carbon monoxide are certain to be found after explosion disasters in mines, and the self-contained breathing apparatus was developed in the past to meet the need brought about by these conditions. Figure 3 shows men being trained in the use of the apparatus. A 2-hour supply of oxygen is carried at high pressure in a steel bottle and is fed to the wearer as needed through a reducing valve. The waste products of breathing are absorbed by chemicals, and the remaining nitrogen and unused oygexn are recirculated.

Electrical Section.—The electrical section endeavors to minimize the possibility of mine explosions originated by electrical circuits, devices and machines that may be used in gassy mines. The equipment that complies with the Bureau's rigid construction standards and passes the safety tests is formally approved and classified as "permissible." Many types of permissible mining machinery are now available for increasing the safety of mining. Figure 4 is a photograph of the laboratory in which this electrical equipment is examined prior to test in a steel gallery outside the building. Other kinds of equipment tested for safety are flame safety lamps used in the detection of gas, portable electric mine lamps of all types, shot-firing equipment and electric-type methane detectors.

Experimental Coal Mine Section.—The experimental coal mine was developed originally to make large-scale studies of coal-dust explosions, and to date approximately 1,600 such explosions have been made in the mine. The purpose is to determine the conditions under which explosions can or cannot be initiated and propagated. As it is impossible for any one to stay in the mine during an explosion, the development of flame and pressure in the mine is followed through an elaborate system of electrical recording instruments devised particularly for this work. The mine has been used also for tests of many other kinds, such as ventilation methods for mines and vehicular tunnels (particularly the Holland tunnels connecting New York and Jersey City), apparatus and methods for fighting small mine fires, practical tests of explosives, design of explosion-resisting mine stoppings, and strength of coal when left as mine pillars. Demonstrations of the explosibility of coal dust and means by which coal-dust explosions commonly originate are made periodically to mining men and other interested persons. The mine is also used at times for instruction purposes in mining hazards, gas detection and the use of rescue apparatus and equipment auxiliary thereto.

Explosives Section.—The explosives testing station makes tests of explosives submitted by manufacturers to determine if they meet the Bureau's requirements for listing as "permissible." These tests include trials to determine whether the explosive will ignite a highly inflammable gas-air mixture under certain standard conditions, the quality and composition of gases produced on detonation, the sensitiveness of the explosive to detonation by friction, the propulsive strength of the explosive, and the rate at which it detonates. All explosives tested are analyzed in the explosives chemical laboratory. Research work is done on the kinetics and mechanism of gaseous explosions and on the determination of the inflammable properties and explosion hazards of combustible gases and vapors found in mines and in various industries. The Bureau's facilities for work along the latter line have been of service in studies of the dangers that may possibly accompany use of some

of the newer refrigerants and anesthetics which are inflammable gases. The work also includes field investigations dealing with the detection and elimination of gases and explosion hazards in manholes, sewers and tunnels, together with laboratory investigations of the development of detecting devices and studies concerning ventilation required under different conditions.

FIGURE 3
TRAINING MEN IN THE USE OF SELF-CONTAINED OXYGEN BREATHING APPARATUS

Gas and Dust Section.—In this section are analyzed all gas samples collected in connection with health and safety in mining and metallurgy. Work is done also on the development of analytical procedures and gas detecting apparatus. Gas masks and mechanical filter respirators are tested for conformity to the Bureau's requirements for safety and efficiency, and research is performed on the development of these devices. Research is in progress on the development of apparatus and procedures for collecting quantitative samples of atmospheric particulate matter. Allied with this work are petrographic, size, X-ray and spectrographic studies of the collected dust.

UTILIZATION OF COAL

Coal Analysis Section.—The laboratories of this section make all analyses of coal and coke purchased by the Government under specifications. In addition, there are analyzed all samples of coal and coke taken in connection with the Bureau's work on safety and efficiency. Approximately 10,000 samples are analyzed annually with duplicate determinations on each sample. Different analyses are made, depending on the requirements of individual cases. For checking against specifications the things needed are proximate analysis, sulphur content and thermal value (B.t.u.). For other purposes an ultimate analysis may be needed.

Coal-Carbonization Section.—The major work of this section at present is a survey of the gas-, coke-, and byproduct-making properties of American coals. The work on each coal includes determinations of the physical and chemical properties of the raw coal, and the yields and quality of all carbonization products at six different carbonizing temperatures. Blends of different coals are tested also. Testing methods which use a 100- to 200-pound charge of coal were developed in cooperation with the American Gas Association.

Figure 5 is a view of the apparatus used in this work. The coal is first placed in a cylindrical sheet-steel retort having a single outlet pipe for the escape of distillation products. The retort is then lowered into an electrically-heated furnace, a portion of which appears (somewhat distorted) at the left of the figure, and the outlet pipe is connected to the condensing and absorption train appearing in the foreground. This train separates the various fractions of the byproducts just as is done in a commercial plant, and their quantity and value are determined carefully. After a test the retort is cut open, and the remaining coke is examined and tested to determine its suitability for commercial use.

Development of this work has made necessary a number of collateral investigations, such as studies of the expansion of coals during the coking process and the effect of weathering (atmospheric oxidation) on coking properties. Industrial methods for dedusting coal and coke are being studied also.

Coal-Constitution Section.—This section conducts studies and researches on the origin, composition, and structure of coals as revealed by the microscope, which have led to the classification of coals into types and subtypes, and to the correlation of coal beds through their

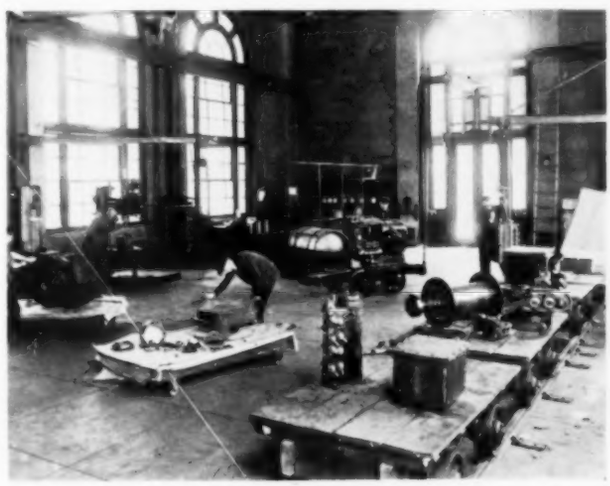

FIGURE 4
LABORATORY FOR EXAMINATION OF ELECTRIC EQUIPMENT FOR MINES

constituents and structures. The various stages in the formation of coal are now well known, and it is evident that every stage is represented within the borders of the United States, ranging from the peat bogs of Wisconsin to the anthracite of eastern Pennsylvania and the graphite of Rhode Island.

Use-of-Fuels Section.—This section is concerned with the utilization of solid fuels, their burning character-

istics, and the properties of their ash. Its main investigations have aimed to establish fundamental principles of combustion and to obtain data of general importance to all or to particular industries, but beyond the scope of what can be done by any one member of an industry. In particular, it does work through which the householder may be helped in burning fuels in

FIGURE 5

EQUIPMENT USED IN TESTS OF GAS- AND COKE-MAKING PROPERTIES OF AMERICAN COALS

stoves and furnaces. The ordinary stove or furnace burns coal on the overfeed principle; that is, fresh fuel is placed on top of the fire. The small stokers for house furnaces, now coming on the market in large numbers, employ mainly the underfeed principle, in which fresh fuel is forced in at the bottom of the bed. The ability of ash to fuse or clinker is important in all applications of solid fuel, and the temperature required to cause this fusion varies considerably with different coals, depending on the chemical composition of the ash.

Coal-Hydrogenation Section.—The production of oil from coal is now receiving much attention, particularly in countries such as England and Germany, which lack petroleum reserves. The day when oil from coal will be an important factor in the United States is still well in the future, but it will arrive without question. In preparation for future need, this section is conducting studies designed to determine the relative amenability of different coals to conversion into oil through the process known as hydrogenation. This consists of forming a paste of finely-divided coal, which is treated with hydrogen under high pressure at an elevated temperature. Chemical reactions take place which convert a large proportion of the solid hydrocarbons to liquid oils. Of course it is desirable to obtain the largest yield of compounds suitable for use in internal-combustion engines. The industry is still too near its infancy to have acquired stability, and it is likely that discoveries and inventions of the next ten years will greatly alter present practices.

The Bureau's plant for studying hydrogenation was designed for continuous operation on a relatively large scale, in contrast to much other experimental work in which small batches of coal have been treated discontinuously. This necessitated equipment for the production, purification, and compression of hydrogen in addition to the apparatus needed for the actual hydrogenation of coal. Also, as the study cannot be carried to a proper conclusion without fractionation and analysis of the oils produced, a well-equipped organic chemical laboratory is an essential part of the section. Investigation of the thermodynamics and kinetics of the thermal decomposition of hydrocarbons is carried on also.

OTHER RESEARCH ACTIVITIES

Metallurgical Section. — Metallurgical work at the Pittsburgh Station is confined to steel; metallurgy of other metals is studied in various other stations closer to the sources of their production. The composition of steel-furnace slags is receiving much attention among metallurgists at present, and this section is investigating the magnetic properties of such slags at temperatures up to 800° C. In an effort to reduce the time required for the production of steel from pig iron and scrap, the section is also attempting to find some reagent which can be added to the charge in the furnace to produce a dispersion of the metal through the slag, so that the reacting surfaces of metal and slag will be greatly increased. Studies are being made also of the possibility of determining the carbon content of steels through use of a coercimeter.

Mining Division.—The work of the mining division is done largely in the field, and four sections have headquarters at Pittsburgh. Under metal-mining research investigations are being conducted on drilling methods for hard rocks, supersonic seismology as a possible means of determining the load carried by mine pillars, and application of compressed air to mining. The coal-mining section deals with numerous problems having to do with methods of producing coal at the working face and transporting it to the surface.

The mine-ventilation section makes studies of the fundamental physics of mine fans and the movement of air in mine passageways together with transfer of heat to or from the air current. The necessity of ventilation results in continuous and heavy expense in all mining operations. In many coal mines over 100,000 cubic feet of fresh air per minute are required, and solution of the problem of carrying the volume through thousands of feet of passageway in an economical manner requires full knowledge of the laws of fluid flow.

The nonmetal-mining section conducts field studies of the production of nonmetallic minerals. Investigations of special problems are made as they arise; one, for example, is the size gradation of primary crushing.

Miscellaneous Analysis Section.—The work of this section cuts across both safety and utilization of miner-

Continued on Page One Hundred and Twenty

Some Demonstration Aids For High School Courses In Physics And Chemistry

● **By Thomas P. Nash, Jr., Ph.D.,** *(Cornell University)*
PROFESSOR OF CHEMISTRY AND DEAN OF THE SCHOOL OF BIOLOGICAL SCIENCES, UNIVERSITY OF TENNESSEE, MEMPHIS

This is a very practical article.

From various sources Dr. Nash has selected certain simple physical and chemical experiments which make effective demonstrations and which are inexpensive and easy to perform. Some of them are familiar exercises. Many are not. All of them are good.

Dr. Nash has been thoughtful enough to mention convenient sources of special materials or apparatus. Generally, these can be obtained from other good supply houses.

At its Nashville meeting early this year the science section of the Tennessee Education Association heard Dr. Nash discuss the material presented in this paper.

●

It has been estimated that about 80 per cent of information is acquired through the sense of sight. Apprehension of fact by processes of inductive and deductive reasoning is, for average human mentality, a far more laborious and uncertain pathway to knowledge. However, students of the physical sciences must of necessity travel the harder route to many fundamental concepts. The fact that students commonly find physics and chemistry more difficult courses than, for example, biology, challenges the sympathetic understanding of teachers who sometimes need to be reminded that even a mediocre endowment of potential reasoning capacity may be encouraged to function by visual stimulation.

For the high school teacher of physics or chemistry, who deals with minds still young and formative, the well-conceived demonstration is a potent pedagogic resource. Failure to employ this resource cannot be excused by paucity of equipment and inadequacy of budget—all too frequent conditions in high school departments. Where demonstrations are not the rule rather than the exception, the failure lies in the teacher's lack of ingenuity, energy, or interest in the job. The resourceful teacher will find close at hand materials with which to work.

Complicated conditions and expensive apparatus are neither necessary nor desirable. In general, a demonstration gains in effectiveness from simplicity and accomplishes its purpose if it elicits the student's interest through eye appeal. It stimulates a thoughtful curiosity as to the mechanisms involved. It is factually convincing.

As examples of effective demonstrations which come well within the resources of high school courses in chemistry and physics and, for the most part, may be accomplished with the simplest materials, the following have been selected from various sources.

KINETIC ENERGY OF MOLECULES AND OSMOTIC PRESSURE

1. Gram Molar Volume—Construct of pasteboard a cubical box of 22.4 liters capacity. Label with Avogadro's number, 6.06×10^{23}. Such a model is helpful in giving the student a concept of the actual volume occupied under standard conditions by the gram molecular weight of a gas; in facilitating calculations of the absolute weights of individual molecules, the weight of 1 ml. of a gas, etc.

2. Movement of Molecules—Put water into a bottle or flask fitted with a 2-hole rubber stopper. Through one hole insert a glass tube extending into the water, and bent at the top at right angles and drawn to a capillary. Through the second hole insert a glass tube above the water, and with a 1-hole rubber stopper attach to the top end of this tube an unglazed clay cylinder (Central Scientific Co., Chicago, No. 79161, $0.20). If a jar of hydrogen gas be inverted over the porous cylinder a fine stream of water is forced from the capillary. The smaller and more active hydrogen molecules diffuse through the porous clay cylinder more rapidly than the larger molecules of the air gases may pass outward, thus building up a considerable pressure in the system. This demonstration is effective, also, in discussions of osmotic pressure and other colligative properties of dissolved molecules.

3. Mineral Flower Garden—Small crystals of very soluble salts of metals which form insoluble silicates ($FeCl_3$, $CuCl_2$, $Ni(NO_3)_2$, $CoCl_2$) are dropped into a solution of sodium silicate (sp. gr. about 1.1). As soon as the salts begin to dissolve, the solutions become surrounded by films or membranes of the insoluble metallic silicates. These membranes are semipermeable, permitting water molecules to pass. The solution within a membrane being hypertonic with respect to the sodium silicate solution, a hydrostatic pressure is built up which ruptures the membrane at its weakest point, the top. This exposes a new surface of the salt solution to the sodium silicate and a new film forms which, in turn, is broken, thus permitting the rapid extension of the little tube of metallic silicate.

4. Air as Semipermeable Membrane — Two small beakers are half-filled, one with pure water and the other with a saturated solution of sodium chloride. Seal both beakers in a desiccator. Within a few weeks it can be observed that a considerable amount of the water has passed over into the solution, and in time all of the water will thus be transferred.

5. Brownian Movement — This interesting phenomenon, which is so closely related to molecular motion, is beautifully demonstrated in the apparatus supplied by Central Scientific Co., No. 71270, $3.00. While a more concentrated light source is desirable, an ordinary electric light will serve.

6. Semipermeable and Dialyzing Membranes—A cellulose sausage casing, ¾-inch size, supplied by the Visking Corporation, Chicago, is very convenient in demonstrations or experiments involving osmosis and dialysis. Thus, a short length of this casing, after wetting in water, may be knotted at one end and tied with string at the other end to a long piece of glass tubing. When the bag is filled with a strong sucrose solution, preferably colored as with methylene blue, and immersed in water, the column of liquid rises rapidly in the tube. This is an impressive demonstration of osmotic pressure.

LAW OF MASS ACTION

1. Displacement of Ionic Equilibria—The effect of concentration upon the velocity of chemical reactions is, perhaps, most simply shown in solutions of electrolytes whose molecules have different colors than one or more of the ions. Cupric bromide has long been a favorite substance for this purpose. In solution the following equilibrium exists:

$$\underset{\text{(brown)}}{CuBr_2} \rightleftarrows \underset{\text{(blue)}}{Cu^{++}} + \underset{\text{(colorless)}}{2Br^-}$$

The color varies with dilution in water. If at the green stage, solid KBr (colorless) or a soluble cupric salt (blue or green) is added, the mass effect of the added bromide-ion or cupric-ion is visually evident in the change of color to brown. If at the brown stage the bromide-ion concentration is reduced, as by addition of solid $Pb(NO_3)_2$, the equilibrium is displaced to the right, as evidenced by a change in color of the system to green or blue.

Ferric thiocyanate is also suitable for this type of demonstration. In water solution mix $FeCl_3$ and NH_4CNS in chemically equivalent quantities. The equilibrium is as follows,

$$\underset{\text{(yellow)}}{FeCl_3} + \underset{\text{(colorless)}}{3NH_4CNS} \rightleftarrows \underset{\text{(red)}}{Fe(CNS)_3} + \underset{\text{(colorless)}}{3NH_4Cl}$$

Dilute to a yellow-red stage, and distribute the solution among four glass jars or other containers. Keeping one portion as a control, observe the effect upon the color of the other portions when $FeCl_3$ is added to one, NH_4CNS to another, and NH_4Cl (solid) to the third.

2. Time Clock—Solution A contains 0.9 gram of HIO_3 in 500 ml. of water. Solution B is freshly prepared as follows: With heating, dissolve 4 or 5 grams of starch (preferably soluble starch) in water; after cooling add 0.25 gram of Na_2SO_3 (anhydrous) and 2.5 ml. of dilute H_2SO_4 (1:10); dilute with water to 500ml. When solutions A and B are mixed, the following reaction occurs:

$$5\ H_2SO_3 + 2\ HIO_3 \rightarrow 5\ H_2SO_4 + H_2O + I_2$$

and the free I_2 gives an intense blue color with the starch. However, an appreciable time is required for this reaction. If the quantities of Solution B are kept constant, and the quantities of Solution A are varied, different times elapse before the blue color flashes up. Thus, take 10 ml. portions of B: to one portion add 10 ml. of A and to a second portion add a mixture of 5 ml. of A and 5 ml. of water. The second system should require just double the time to exhibit the blue color, since the concentration of one of the reactants has been halved.

OXIDATIONS

1. Oxidation Producing Light—(Ref., *Journal Chemical Education*, 11, 142, 1934)—Prepare Solution A by dissolving 0.2 gram of "Luminol" (3-aminophthalhydrazide, Eastman Kodak Co., Rochester, N. Y., No. 3606, $0.50 for 1 gram) in 10 ml. of 10 per cent NaOH and add water to make 100 ml. Solution B contains 0.5 gram of $K_4Fe(CN)_6$, 20 ml. of 3 per cent H_2O_2, and water to make 100 ml. Each solution may be diluted further with water as desired. When the two solutions are mixed a brilliant fluorescent light is emitted, which is especially impressive in a darkened room. Cubes of ice may be present in the reacting mixture; a cloth may be dipped alternately in the two solutions; the solutions may be mixed as jets from atomizers, producing a fountain-of-fire effect; etc.

2. Methylene Blue (Mb) Catalysis—Methylene blue is a reversible oxidation-reduction dye. In the oxidized state, Mb, it is blue; in the reduced state, MbH_2, it is colorless. Mix in a test tube 5 ml. of water, 1 ml. of 2 per cent glucose solution, 1 ml. of 0.001 molar methylene blue solution and 1 ml. of 10 per cent NaOH solution. Warm the mixture gently until the blue color disappears. The alkali fragments ("activate") the glucose, and the fragments are oxidized by the Mb which is correspondingly reduced to MbH_2. Stopper the tube and shake. The mixture again becomes blue, the oxygen of the air having reoxidized the MbH_2 to Mb. On standing, the color again disappears, and this process may be repeated until all the oxygen or glucose is consumed. The quantity of methylene blue does not change; it acts as a typical catalyst, passing hydrogen from the glucose to the oxygen of the air, the final oxidation product being water.

3. Activation of Oxygen—That the burning of gas in air activates molecular oxygen can be demonstrated in the following interesting fashion. Place a small cube of ice in a clean beaker or dish until several ml. of water have accumulated. Pour off this water into a clean test tube to serve as a control. Now hold the ice in a pair of tongs above the beaker, and direct against the ice the full colorless flame of the Bunsen burner, collecting the drip in the beaker. Pour 5 ml. of this water into a second tube. To each of the two tubes add in order 1 drop of acetic acid, 2 drops of potassium iodide solution, and 2 drops of starch solution. The first tube should remain colorless, while the second tube should turn blue. The explanation is as follows: As the hydrogen and carbon of the gas are oxidized at high temperature by oxygen of the air, the latter is split into atomic oxygen which reacts with water of

Continued on Page One Hundred and Twenty-one

Amateur Taxidermy

● **By Sister M. Gabriella, O.S.F., B.S.,** *(Duquesne University)*
SAINT FRANCIS ACADEMY, PITTSBURGH, PA.

At first thought, taxidermy might seem to be beyond the capabilities of high school students. It really is not, especially if there is a teacher who knows even a little about the work and who is interested in helping others to learn.

Sister Gabriella is an enthusiastic instructor whose biology classes are always engaged in interesting projects. Taxidermy is one of these. It is a good teaching device, one worth trying.

Simple directions for beginning the work are here given.

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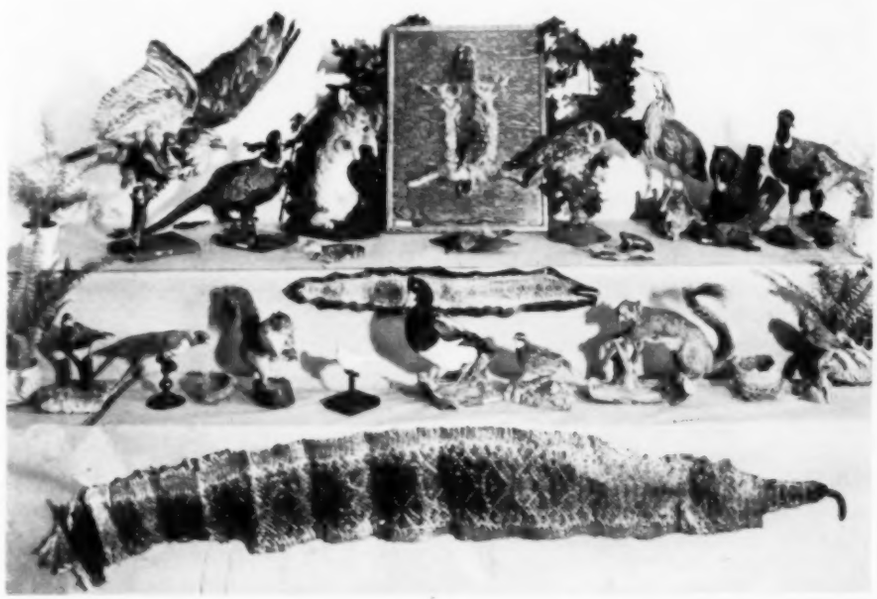
Necessity did us a good turn, some six or seven years ago, when it drew our attention to the instructional values of taxidermy. Several hunters were generous to our biology class that year, and left us rabbits and squirrels to use as we pleased. It would be an excellent thing, we thought, to have these animals mounted for our school museum, but skilled taxidermists asked from eight to ten dollars for preserving each one. This cost was prohibitive; so we abandoned the thought of professional service, and decided to work on the specimens ourselves. A visit to the library gave us information on how to skin, cure and mount, and we soon learned much more by the practical, but often discouraging, trial-and-error method.



EXAMPLES OF THE WORK OF SISTER GABRIELLA AND HER PUPILS

We did not attempt too much at the start. The first rabbit was skinned, the cured pelt spread, the legs and skull filled in, and the whole mounted on a flat board. Encouraged, we continued our sometimes unsuccessful experiments. Some of the results achieved were a far cry from Mother Nature's models, and many a self-respecting rabbit and squirrel would be ashamed to be seen in the fancy shapes we modeled. However, experience brought a modicum of skill and soon we had, if not perfect specimens, at least presentable ones.

In this paper we shall record some of the important bits of information which our reading and experience have gained for us.

PRELIMINARY PREPARATIONS

Because their skins are tougher than those of cats or rabbits, squirrels are the best animals for beginners to use. First, wash off any blood stains. Make accurate notes on the specimen as it lies before you. Draw an outline of the dead animal by placing it on its side in a walking position, and outlining it with a pencil. This will help later on in keeping the proportions right. Prepare a label stating the locality from which you obtained the specimen, and the name, date, and sex. Then record the following measurements.

1. Length from end of nose to root of tail (place where tail joins the body) keeping the head stretched out.
2. Length of tail from the root of the tail to the end of the vertebrae.
3. Length of hind foot. Bend heel at right angle and measure from outer extremity of angle to tip of the longest toe including the nail.
4. Height at shoulder; lay the animal in walking position on the side and measure.

Note the color of the eyes and other soft parts, either recording the color with water colors or by using a paint color chart to identify exact color combinations and shades. This record is invaluable when you start finishing and mounting your specimen.

SKINNING

Place the animal on its back on a table with its head to your right. With a sharp knife or scalpel, pierce the skin near the center of the body and open it to the anus. Be careful not to cut too deep, for if you enter

the body cavity you will have more than trouble on your hands. With your thumbs and forefingers, separate the skin from the adhering flesh as far back as you are able. Then work toward the tail until you can pull the tail out, or at least sever it from the body. Push the skin away from one of the hind legs; cut the thigh away from the body and pull the skin inside over it until all the flesh is exposed. Then remove as much of the flesh as possible. Repeat the process with the other hind leg. Now the body may be gradually worked out of the skin by turning the skin inside out until you come to the forelegs. Cut them at the body junction to separate them from the body, and work them back in the manner used for the hind legs. Draw the skin very carefully over the neck of the animal until you reach the eyelids. Work down to the lips, but do not sever the tip from the skull. The lips, if fleshy, may be split from the inside and the flesh removed. Now remove the eyes, the flesh from the cheeks, and the tongue. Sever the skull from the neck. With a flat wire bent at an angle, remove the brain through the occipital opening. If you care to save the brain, remove part of the skull bone carefully, and lift out the brain. After filling the cured skull cavity, replace the removed part of the skull or fill it in so that it seems to be complete. When skinning, if the animal bleeds profusely, scatter oatmeal between the skin and the body to soak up the blood.

CURING

Then the curing process begins. Two methods are in use: the wet and the dry. The wet method (salt and alum bath) has the advantage of keeping the specimen soft and flexible. It is, however, difficult for a beginner and requires considerable space for storing wooden, glass, or lead-lined tanks in which the solution is kept. The dry method is, we believe, the easier and safer for beginners. With small birds, it is the only type that can be used.

After the skin has been removed, examine it for bullet holes or tears caused by careless skinning. Sew up every hole. Then mix together in a dry container two-thirds of powdered alum and one-third of arsenic. With a small paint brush (either water color or oil), apply the dry mixture and rub it well into the flesh. Paint any bones that have been left, as well as the cavities formed by the bones of the skull. Do not inhale this poisonous powder. Keep your hands away from it. If every part is thoroughly gone over, the specimen will keep indefinitely. You may take your time in mounting it, but for good results it is safer to do the mounting as soon as possible for the skin may become parchment-like and difficult to handle.

MOUNTING

The mounting of the specimen now begins. Wire reinforcements are necessary for legs, backbone, and tail. For each leg, cut a wire that will extend from the sole of the foot to the thigh, adding about three inches for projection beyond the sole of the foot, and five inches over the required length for the top of the leg. Use No. 15 annealed wire. If you cannot obtain that, use hard iron wire which has been heated to redness and then gradually cooled. If the wire is rusty, sandpaper it. The forearm bone wire is measured the same way as the leg wire. For the tail, use a piece of No. 17 wire long enough to reach from the center of the body to the end of the tail. File the tail end to a point. Cut another piece of No. 15 wire twice the length from the back of the head to the root of the tail; this will be the body wire. Straighten the wires; lay them on the table, and remember the special purpose of each.

Now for the actual mounting. Pass the wire through the paw from the outside, allowing three inches of it to protrude beyond the sole. Bend the wire to imitate the bones of the foot. Use linen thread for tieing at the tibia and femur positions. Start building the muscle by wrapping cotton, linen or tow around the wire and tying it in place or twisting it with thread. Be guided by the measurements and drawings you made in the beginning. Pictures of the animal from nature books may help. When you have finished, anoint the skin of the leg with arsenical soap or with the mixture of alum and arsenic. Rub a little wet clay or thick soap over the tow or cotton so that it will slip easily into the skin. Start turning the skin right side out, adjusting it from the foot up. Do the same for the other three legs. Remember to keep the two hind legs and the two forelegs equal. Twist the tail wire with cotton and bind it down firmly with thread. If it was necessary to splice the tail after inserting the wire, sew the tail up.

After finishing the work with all the appendages, start the torso. Punch a small hole into the skull a little above the occipital opening and pass through it the wire you measured for the body, letting it come out through the nasal cavity and the end of the nose. Fill the jaws with soft clay or cotton, anoint it again, and start working the skin over the skull. When you reach the eye openings, insert either a tack or a large pin to keep the skin from stretching. It may be advisable to attach the skin at the top of the skull to the skull bone by means of a tack. The legs, tail, and skull are now in place, and we are ready to wire all the parts together.

The skin lies before us with the right side out and the legs in the same position they occupied when we made the sketch. Bend the inner ends of the foreleg wires back from the head of the humerus at an obtuse angle and let them cross each other, making an X (Fig. 26-26a, Hornaday's *Taxidermy*, p. 119). Make a loop or ring with the body wire just at the place where these foreleg wires cross. Now stick the foreleg wires through the ring, allowing them to cross again, placing the left leg wire under the right. Measure the distance from the extremities of the toes, consulting your outline and sketch to verify the length of the leg. Tighten the wires running through the loop by twisting the three wires until the two legs become firmly attached. Straighten the body wire, and make the loop for the hind legs five inches below the first. Make the same

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Sensory Experiences
In Science Instruction

● By Howard J. Leahy, A.M., *(Tufts College)*
INSTRUCTOR IN EDUCATIONAL PSYCHOLOGY, DUQUESNE UNIVERSITY

The wide-awake science teacher always takes advantage of the opportunities for special instruction that the location of his school affords. Not many teachers, however, would think of teaching science in an out-of-doors laboratory provided by Nature. Here is a teacher who achieved worth-while results by so doing.

Mr. Leahy makes some interesting comments on this project as well as on the use of motion pictures in the classroom, and the instructional value of class trips. He has had wide experience in the teaching of high school science.

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For a considerable time science instructors at the secondary level, as in other fields of study, have been seriously concerned with enriched methods of teaching. No longer do they cater to the academically minded pupil in biological and physical sciences who may anticipate specialized training beyond the high school. They are aware of the needs of a much larger group who will be expected to make satisfactory adjustments to life situations immediately upon leaving the secondary school. As a consequence, verbalistic methods of instruction are being supplemented by techniques designed to motivate and to stimulate significant growth and development on the part of intelligent future community members and wise consumers.

Groups of science students are visiting numerous industrial plants, food factories, and other utilitarian enterprises under the guidance of a trained personnel and interested teachers. Youths are gaining insight into modern, practical problems of the world in which they live by making first-hand observations of men and women actually engaged in the production of commodities upon which humans depend for their healthy existence and wholesome happiness.

Pasteurized milk, which the boy or girl comes to appreciate as a fundamental, nutritive component of his daily diet, will not be a mystifying foodstuff hereafter. Alert instructors in co-operation with modern dairies can assist him to understand more completely the meaning of pasteurization.

The concrete qualities of other journeys to realistic, meaningful destinations are responsible for the attention that is given now to the school excursion as an important sensory experience for science pupils. In many cases, it provides an adequate setting for the comprehension of basic scientific facts and principles.

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Some years ago, the author found himself teaching science in a high school with a student population of about 1,400. Fortunately, the physical plant was located on a large tract of land supplied with a fine wooded area surrounding a natural ravine through which flowed a picturesque New England rivulet. During the opening days of the annual session, entire classes of approximately thirty-two students each, in biology, chemistry, and physics visited this prospective outdoor laboratory. Developmental possibilities were discussed with the eager youths while they were seated on crude, 2" x 12" boards arranged appropriately on the banks of the ravine.

Contributions flowed with remarkable speed from the active minds of these young scientists. A group of physics students planned the construction of a stone dam equipped with a penstock that would lead to a turbine constructed out of tin plates brought from home. Here they would have a model hydro-electric plant to assist in studying the use of water power in the production of electricity. Someone even suggested that a generator be provided to produce a small amount of current.

Once the work started, it progressed quite smoothly and with much force. Replicas of overshot and undershot water wheels were built and put into operation along the stream. Applied chemistry students made a sand filter bed with all the essential layers of sand, gravel, loose rock, and slate arranged in accurate proportions to demonstrate one method of purifying water for drinking purposes.

Nature trails, traversing rustic wooden bridges, were blazed by biology students who later identified and labeled plant and tree specimens. Small aquaria, vivaria, rock and vegetable gardens were successfully established.

It was a thrilling spectacle to watch boys and girls energetically transforming a swampy ravine into a natural and physical science laboratory. In the early fall, spring, and summer months they spent many pleasant hours acquiring an intimate appreciation of their natural surroundings while learning how to use these forces of nature.

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The powerful influence of commercial motion pictures and radio offerings on the behavior patterns of young people has been recognized from the beginning of movie and radio entertainment. Educators have tried to adapt these forms of sensory stimulations to classroom procedures in order to restore the child's interest in the formal discipline of productive accomplishment.

When used intelligently and with discretion, the cinema and the radio are valuable aids in reducing the

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A Technique Of Directed Study In Chemistry

● **T. H. Allen**
HEAD, DEPARTMENT OF CHEMISTRY, MALE HIGH SCHOOL, LOUISVILLE, KY.

Regardless of how teachers in general may feel about it, in a number of schools single laboratory periods are already here.

When they are adopted, older methods of instruction must be changed to meet the new conditions. Professor Allen tells what has been done in the Louisville Male High School since the science classes were changed from a double to a single period basis. His account will be helpful to other teachers who must meet this problem.

The informal familiarity-reading test referred to by Professor Allen is printed at the end of this article.

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In 1928, the classes in the science department of Male High School in Louisville, Kentucky, were taken off the double period basis. The single periods, however, were lengthened from forty-five to fifty-six minutes. This change resulted in a net loss of three hours and ten minutes of instruction time for each section per week. The time schedule for each section had been two double periods each week for laboratory instruction and three double periods per week for teacher demonstration, socialized discussion, drill, and other techniques of the classroom. Under the old plan, the science teacher had three sections of about twenty-five pupils each. He was now given five sections of approximately the same size. This change simplified schedule making and cut down per capita cost of instruction, but it put the science teacher in a dilemma as to what to do in order to cover adequately the subject matter of the course and to meet the laboratory time requirement.

After considerable thought and investigation, the chemistry department adopted a plan of directed study for classroom work. We organized units of work based on closely related material and prepared elaborate outlines covering every phase of the unit. We used this plan for five years, but the plan was time-consuming and there always seemed to be something lacking, some technique which would probably round out the work on a unit. We thought of various devices, and finally adopted the following modification of the directed study plan:

A. **Unit of work assigned.**
   1. Exploration.
   2. Presentation.

B. **Work period.**
   Pupil study, teacher demonstration, socialized discussion, teacher telling, consultation of supplementary material, drilling, quizzing, pupil demonstration, recitation, and pupil laboratory experiments.

C. **Test.**
   Administration of an informal, objective *familiarity-reading* test.

It can be observed that the plan outlined differs from other plans of directed study chiefly in the use of the familiarity-reading test. The content of each test is based on a unit of work and follows, very closely, the declared objectives of the course in chemistry. The text is combed for test exercises on each unit, and we have collected a very large number of items, so that it is very easy to change a test when we think it necessary. The purpose of each test, test conditions, and the extent of the unit are given in the introduction to the test. For example, the test on halogens includes the following introduction:

> This test is designed to measure your familiarity with and your ability to read understandingly the sources of information about *halogens*. You are to use your textbook, your notes, the dictionary, and other supplementary material.

As soon as the pupil has become "test wise," this formal introduction is omitted because it takes up too much space and the instructor can, if necessary, write this part of the test on the blackboard.

The test is divided into sections of true-false, recall, multiple response, and matching exercises. Again, minute directions are given for taking each part of the test until the pupil is familiar with each type of test exercise. We then substitute a short paragraph giving blanket instructions for taking the test:

> Indicate the true statements with plus(+) and the false with zero (0). Fill in the blanks with (a) correct word(s) or term(s) and underline the correct word(s) or term(s) within the parentheses.

These blanket instructions cover the single choice, recall, and multiple response exercises, but special instructions have to be given for the matching exercises. We use these:

> Number the item in the first column to correspond to the item in the second column with which it is directly associated in meaning. Do not use a given number more than once.

We do not attempt to construct power tests but confine ourselves to rate tests only. We have found that the true-false, multiple response, and matching exercises tend to bring out individual differences, and the recall type can be used very effectively in emphasizing laws and principles. The test is mimeographed in order that each pupil may have a copy. We have to be careful about the length of these tests. We are measuring the pupil's familiarity with the material as well as his ability to read understandingly, and it will take the pupil longer to cover this kind of test than it will for him to take an achievement test.

We have learned, by experience, to be able to sense when the pupils feel that they have made adequate preparation and are ready for the test. The work of the chemistry department at Male High School is so organized that all sections of Chemistry I take the test on the same day, and the same thing is true for all sections of Chemistry II. We announce the test a day before giving it. We do this for two reasons: we want the scores of all pupils; and, strange as it may seem, a boy does not want to miss taking the test at the regular time, for he knows that if he is absent on the announced day he will not be permitted to attend the socialized discussion of the test. The pupil works on the test independently of the instructor and the other pupils. He is told that he may use any information except his neighbor's. No one is allowed to ask questions about the exercises. All the information he may need is in his text or notes. Since this is a rate test, the pupil is told that he may use the entire period and that no more time will be allowed. The pupil hands his paper to the instructor at the end of the period.

On the next day the papers are exchanged, each section scoring its own test papers as the instructor reads the key. The scored papers are returned to the instructor, who checks them for errors. Surprisingly few errors in scoring will be found because the pupil scorer is required to write his name at the top of the page as the scorer. After the errors are checked, the test paper is returned to the examinee and he may ask questions about his mistakes or any exercise he may care to discuss. We encourage this questioning attitude. We like for them to ask us where the exercise is found in the text if they were unable to find it. The instructor teaches the test, and a lively socialized discussion nearly always results. The pupil knows that some of the exercises or a variation of them will be included in the achievement test near the end of the grading period. The papers are then returned to the instructor who rechecks them and tabulates the scores. The papers are then destroyed.

The raw scores of all the pupils who took the test are transmuted into letter grades by a statistical method. The scores are put into a frequency distribution, and the mean and standard deviation (S. D.) are determined.[1] The letter grade equivalents are then estimated in terms of the distribution curve. We know that this curve will not always be normal; in fact, very few curves are normal. If the S. D. is large, we may or may not have either E's or A's. We have to use common sense. One would expect a large amount of left skewness in the scores made on an objective familiarity-reading test, but such is not the case. If sufficient care and thought are put into the selection of test exercises, the distribution will be almost normal even for a rather small number of pupils. As an illustration, 142 boys took the test on the halogens. There were 3 E's, 34 D's, 62 C's, 37 B's, and 6 A's. On a percentage basis this is 2.11% E's, 23.94% D's, 43.66% C's, 26.06% B's, and 4.23% A's.

We favor this method of transmuting raw scores into letter grades because of its effect on pupil morale. The poor pupil works with the hope that he may escape an E, and the best pupil knows that he is going to get a square deal. The pupils believe that the procedure is fair to them and that it places each pupil in the proper group. The instructors like the method because it removes the subjective element in grading. There is never an accusation of favoritism. The letter grade made on the test is recorded and becomes a part of the pupil's semester mark. There appears to be a close relation between the marks made on the familarity-reading tests by the pupil and his marks on achievement tests, which are given at regular intervals during the semester and on which the pupil is allowed to use no references whatever. For example, the record of pupil N.F. is given, the number in parentheses indicating the test number: (1) B, (2) A, (3) A, (4) A, (5) A, (6) A, (7) A, (8) A, and (9) A. The record of pupil S.B. is shown in the same way: (1) C, (2) C, (3) C, (4) C, (5) C, (6) C, (7) C, (8) C, and (9) C. In each case the tests numbered 3 and 9 are achievement tests; the others are familiarity-reading tests.

We do not believe that the objective familiarity-reading test is a panacea. We do know that it has given us a deeper appreciation of one of the greatest difficulties a pupil has in the study of chemistry. The inability to read understandingly limits his ability as a real student of chemistry, and we suspect that it is the basis of his trouble in other courses. Just what to do is a problem. We are not blaming those who are responsible for the mastery of the fundamentals, but we are trying, in the socialized discussion of the test, to teach him to interpret the written word.

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FAMILIARITY—READING TEST

THE HALOGENS

Text: *A First Book in Chemistry.*
Author: Robert H. Bradbury.
Chapters: X, and XXXI, Section 174.

This test is designed to measure your familiarity with and your ability to read understandingly the sources of information about the *Halogens.* You are to use your text book, your notes, the dictionary, and other supplementary material. Follow carefully the directions for each part of the test. *Do not guess.*

Section I

TRUE-FALSE EXERCISES

DIRECTIONS: Each of the statements below is either "True" or "False." If the statement is *true,* place a plus(+) in the blank at the left of the statement. If the statement is *false,* place a zero (O) in the blank at the left of the statement. Your score for this part will be R — W.

____ 1. Dry chlorine is inactive.
____ 2. An active element seldom occurs native.

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[1]The use of the S. D. and mean in transmuting scores into letter grades is explained by Garrett, Henry E., *Statistics in Psychology and Education,* Longmans, Green and Co., New York, 1934, pp. 99-101.

Albertus Magnus, Scientist Saint

● **By Nicholas Dietz, Jr., Ph.D.,** *(Columbia University)*
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Saint Albertus Magnus, or Albert the Great, was one of the finest and most influential of thirteenth century scholars and teachers. A German Dominican friar, theologian, preacher, philosopher, teacher of the learned St. Thomas Aquinas, Albertus was also an experimentalist, and one of the great scientific investigators and compilators of the Middle Ages.

His activities covered practically the entire gamut of the sciences of his time. He studied and described virtually the entire cosmos from its stars to its insects. His contemporaries conferred the title of "Universal Doctor" upon Albertus because of the unparalleled universality of his knowledge. His solemn canonization with the title of "Bishop, Confessor, and Doctor" in 1931 has focused the light of historical interest anew on this saintly scientist.

Dr. Dietz suggests that the world of Science adopt the "Universal Doctor" as its special patron.

●

If any lingering doubt remained that a conflict ever existed between Science and Catholicism, that doubt has been gloriously dissipated by the attitude and actions toward Science of the present incumbent of the Chair of Peter. For his Holiness, Pope Pius XI, has consistently and even enthusiastically looked with favor upon the accomplishments of modern science and invention. As was pointed out in the September, 1937, issue of the *Science Counselor*, radio station HJV of Vatican City is one of the finest not only in Europe but in the whole world. The modern Vatican City electrical power station, its railway facilities and other twentieth century means of transportation, its modernized library facilities—these and many others indicate that the present Pontiff smiles benignantly upon science and technology. The recent establishment of the Pontifical Academy of Science, to which men of many nations have been elected (including six Americans, three Catholics and three non-Catholics), also presents a picture of the great Pius XI as a generous patron of science.

Therefore, it seems most fitting that the canonization of a man who was, perhaps, one of the most brilliant students and teachers of science in the last two thousand years, as well as a great leader in the world of theology and morals, should have been solemnized during the reign of this great Pontiff. The canonization referred to was that of Albertus Magnus on December 16, 1931, when he was solemnly proclaimed not only a saint, but also the twenty-eighth Doctor of the Church.

Albertus Magnus, or Albert the Great, was born at the end of the 12th century (1193), the eldest son of the Count of Bolstädt, in Suabia, Germany. His forebears were distinguished in military affairs. Albertus, who was to become one of the most outstanding and influential men of a century—the thirteenth—which saw many other really great characters in the Christian, Moslem and Jewish worlds, went to Padua, in Italy, to study not merely the liberal arts but also medicine and law. There he came to know and love the newly founded (1215) order of Friar-Preachers, the Dominicans or Black Friars. He met the eloquent Jordan of Saxony, Master General of the Order, and joined the friars (1228); soon afterwards he completed his theological studies at Cologne.

The Dominicans, like the Franciscans (whose Order had just been founded in 1210 by the lovable St. Francis of Assissi), were men who went *to* the people, who lived in growing towns where they could preach to the multitudes, rather than *away* from the people in secluded monasteries as had been the common practice of Christian monks prior to the 13th century. Both of these great orders of friars, fighting for the redemption of the masses, soon realized that this task was well-nigh impossible unless they could also influence and control the education of the leaders of the people, i.e., the upper classes.

They strove, therefore, to obtain chairs in the universities which were rapidly coming into prominence in the early 13th century. In this way, Albertus, who had quickly demonstrated that he was gifted both as a scholar and a teacher, was appointed to teach at Hildeshein, Freiburg (in Breisgau), Ratisbon, Strasburg, and, as his fame spread, at the renowned University of Paris. Later he founded and governed a *studium generale* of his Order at Cologne. In that city, among other famous students and followers, was Albert's most distinguished pupil, Thomas Aquinas, who subsequently became the most learned as well as the most saintly of the scholastic philosophers. Albertus recognized and proclaimed Thomas' genius, and strenuously defended the Thomistic teachings after the rather early death of Aquinas.

Albert's philosophical and scientific works were so extensive that they constituted a library in themselves. He wrote a series of encyclopedic treatises dealing with almost every known subject in theology, philosophy, and the natural sciences. As one authority puts it, Albertus was "probably the greatest scientific investigator of the Middle Ages, whose writings constitute the most colossal encyclopedia ever undertaken and completed by a single person." Like virtually all other philosophical and scientific writers of the Middle Ages, Albertus borrowed considerably from Aristotle with numerous

additions derived from various pagan, Christian, Moslem, and Jewish commentators (including particularly the Arabian Ibn Sina and the Jewish physician-scientist, Maimonides), in addition to his own personal observations. Certain of Albertus' works have evidently been lost, for he himself states that he composed works on music, geometry, and astronomy which do not appear in the two complete collections of his printed works, one in 26 folio volumes, (Jammy, 1651), and the other 38 quarto volumes (Borgnet, 1899). Numerous smaller special editions are listed by George Sarton in Volume 2 of his comprehensive *Introduction to the History of Science* (Williams & Wilkins Co., Baltimore, 1935) and by the Dominican Rev. Thomas M. Schwertner in his volume *St. Albert the Great* (Bruce Publishing Co., Milwaukee, 1932). Father Schwertner's book is especially recommended for an interesting summary of the life and works of St. Albert.

Dr. Sarton writes:

"The best parts of Albert's works are the zoological and botanical books. The zoology opus *De Animalibus* is divided into 26 books of which the first 19 are a paraphrase of Aristotle's three treatises. Books 20-26 contain new matter, partly derived from personal observation or from direct information. Books 20 and 21 deal with generalities; book 20 with the nature of animals' bodies, their structure and forces; book 21 with perfect and imperfect animals and the causes of their perfection or imperfection (this is a kind of comparative animal psychology); books 22-26 are devoted to the description of individual animals, these being introduced in each chapter in the alphabetical order of their Latin names . . . Book 22 deals with men, *gressibilia* (i.e., quadrupeds; our mammals, excepting bats, whales, and seals); book 23: *volatilia* (i.e., birds and bats); book 24: *aquatica* or *natatilia* (i.e., fishes, whales, seals, cephalopods, shellfishes, water snails, and other aquatic animals); book 25: serpents (i.e., snakes, lizards, salamanders) . . . book 26: *vermes* (i.e., worms, insects, toads, frogs, land snails). Many of the animals were here described for the first time."

According to Stadler, Albertus was the first man to mention the weasel, two kinds of martens, and the arctic bear. It is said that he was also the first to suggest that the peculiarities of cats are due in great part to climatic conditions. He discovered the similarity between the teeth and claws of cats and lions. His veterinary knowledge was remarkably extensive. He was one of the pioneers in animal anatomy and animal psychology. Lynn Thorndike says: "Albert has not only observed animal life widely, he has also performed experiments with animals as he apparently did not do with plants. Crude experiments these may be, but they are at least purposive." Stadler points out that from Albert's zoological treatises one could reinhabit the German forests with animals found therein. Wassmann and Balss prove that his name cannot be overlooked in the history of evolution. Balss also states that Albertus laid the foundation of comparative zoology through his observations of different kinds of squirrels in the various countries which he had visited. Sarton remarks: "He had many opportunities of observing things in the course of his long travels as provincial of his Order (the Dominican rule obliged him to travel afoot). He observed animals in the Danube region, in the vicinity of Cologne, Augsburg, Worms, Treves in Friesland, Holland, Brabant, Italy . . . He also collected information from the many people of all classes he came across in the course of his missions."

—Courtesy Journal of Chemical Education

ALBERTUS MANGUS
Scientist and Saint

Albert was particularly fond of birds, of which there were many varieties in thirteenth century Germany. He spent considerable time studying and describing them, their habitats and distinguishing characteristics. As Vesalius suggested several centuries later, Albert was familiar with comparative bird anatomy. Strunz says: "Albert was the first to speak intelligently, with understanding, wisdom and childlike simplicity, about the sex life of birds."

He loved to hunt, and the result was a wealth of written information on game birds, geese, ducks, partridge, etc., as well as buzzards, and a special treatise on falcons which was an improvement upon the classic work of Frederick II. He discovered that

swans sing in pain and not to drive off enemies. He was the first German to describe the German black stork. Albert's love of birds was so well known that the earliest representations of him in ecclesiastical art show him surrounded by various species of his feathered friends. His bird lore teachings no doubt contributed to some of the ornithological decorative splendor of the great cathedrals built during the thirteenth century.

Albert was much interested in marine life, partly perhaps, as the Dominican Schwertner suggests, because fish fare was almost perpetual in Dominican refectories. His interest extended enthusiastically even to angling. He wrote extensively of the habitats of eels and salmon. He was one of the first to distinguish anatomically between fish and amphibians. He was an authority on oysters, and was one of the first to suggest oyster beds as we now know them. From his personal experiences in Friesland he describes whales and whale hunting and the use of blubber.

On the grounds of his own observations he courageously denied various errors, myths, and superstitions concerning sea and land animals, even when such denials clashed with the great authorities like Aristotle, Pliny, Galen, etc.

Stadler remarks that Albert was also greatly interested in entymology. Probably no medieval man so minutely and accurately describes such insects as bees, ants and spiders. According to Schwertner:

> "What Fabre's classic descriptions are to our days, that Albert's pictures of insect life were to Europe for 300 years. He studied the anatomy of bees as none of his predecessors had. Jessen declares that he was the first to point out the belly marrow and structure of their feet and proboscis. In his botanical works he added supplementary data on these points as also keen observations regarding crabs and scorpions. Stadler insists that Albert's researches into the life and habits of ants were the finest achievement in this field during the entire Middle Ages."

Albert's *De Vegetalibus* consists of seven books of which Schwertner writes as follows: "The first book deals with the question of plant souls. The second book has to do with a classification of plants in which Albertus comes very near modern times in the norms he lays down for distinguishing one plant from another. The third book discusses seeds and fruits. . . . The fifth treats of the medicinal properties and effects of plants. The sixth describes trees in alphabetical order. The last book is a treatise on agriculture. Albert is the first European to mention and describe spinach, the relation of grapes to the vines and leaves, the distinction between buds and flowers, the influence of heat and sunlight on the bark of trees. He anticipates Knight by centuries in holding that sap is odorless in the root but fragrant in the trunk and branches. He is the first man to refer scientifically to the rarity of duplicate leaves. He established the difference between thorns and thistles. He had clear ideas on grafting—his remarks on the subject anticipate Luther Burbank."

Albertus also understood botanical geography in a rudimentary way. Ellison Hawks says: "His description of the apple, its three coats, the five-chambered core, the floral receptacle above the seed with testa and two hemispheral cotyledons is far superior to anything in any earlier writer." This author also states: "There was one man — Albertus Magnus — who did something [during the Middle Ages] to arrive at a scientific study of plants as living things. This had practically been at a standstill since the days of Aristotle." In *Geschicte de Botanik*, Meyer states that no botanist before Albert's time can be compared with him with the exception of Theophrastus with whose work Albertus was unfamiliar.

Like his great Franciscan contemporary, Roger Bacon (who will be remembered as the first exponent of the inductive method in science), Albertus was also a keen student of chemistry and alchemy. To quote Schwertner:

> "Though the knowledge of chemistry was very rudimentary in the Middle Ages and hampered by the most grotesque experiments, Albert was familiar with many chemical processes and their operations such as distillation and sublimation, purification of gold and silver by cementation and the use of lead. He knew that mercury may be successfully distilled without loss of weight. He recognized that wine, when heated, gives off a substance 'supernatant' and 'inflammable' [alcohol]. He taught that cinnabar is produced by the union of mercury and sulphur; that sulphur attacks all metals but gold; that pure arsenic is produced by heating two parts of soap with one part of orpiment (arsenic trisulphide); that the nature of arsenic is metallic, that nut galls are a source of tannic acid; that the compounds which he called *marchasita* include iron, zinc and copper pyrites and other sulphides of metallic luster. According to Cajorie, of the University of California, Albert knew as early as 1250 that gunpowder could be prepared from sulphur, saltpeter, and charcoal. He introduced the term *vitroleum* to designate sulphate of iron. In a recent issue of "The Laboratory," published by the Fisher Chemical Company, of Pittsburgh, it was shown that Albert knew the color reaction between gall nuts and vitriol."

Professor John M. Stillman, of Stanford University, writes in *The Story of Early Chemistry* (New York: 1924):

> "Of the great value of the work of Albertus Magnus in helping to spread the knowledge of chemistry of his time there can be no doubt. . . . He presents this knowledge with a clearness and directness that characterizes him as one of the ablest thinkers and writers of his century. . . . This very clarity of expression—free from intentional secrecy or mystification—must have given his works an important value in helping to lay the foundations for sane and sensible chemical points of view, in a time when, according to many writers of those times, fraud, charlatanry and imposture in alchemy were very prevalent."

The following translation by Stillman from Albertus' five-book opus: *De Rebus Metallicis et Mineralibus* illustrates Albert's style as well as his general attitude toward chemistry and alchemy:

> "Those who operate much in copper in our region, namely in Paris or Cologne and in other places where I have been and have seen them at work, convert copper into brass by the powder of a stone called *calamina* [copper and zinc ores]. And when this stone evaporates there still remains a dark brilliancy turning slightly to the appearance of gold. But that it be rendered paler and thus

more like the yellowness of gold, they mix with it a little tin by reason of which the brass loses much of the ductility of the copper. And those who wish to deceive and to produce a brilliancy like gold retain the stone (calamina) so that it remains longer in the brass in the fire (or furnace) not quickly vaporizing from the brass. It is [thus] retained by *oleum vitri* (liquefied glass), for fragments of glass are powdered and sprinkled in the pot (testa) upon the brass after *calamina* is introduced, and then the glass so added swims upon the brass and does not allow the stone and its virtue to evaporate, but turns the vapor of the stone back into the brass, and thus the brass is long and strongly purged and the feculent matters in it are burned away. Finally, the *oleum vitri* vaporizes also and then vaporizes the virtue of the stone, but the brass is made much more brilliant than it would be without it. He who desires to simulate gold still more completely repeats these operations of heating (*optesim*) and purging of the melted glass frequently and mixes with the brass, silver instead of tin, and thus it is made so red and yellow that many believe it to be gold itself when, in truth, it is still a kind of bronze (or brass, *aes*).

"Besides, we have never found an alchemist so-called, operating generally (*in toto*) but that he rather colors with a yellow elixir into an appearance of gold, and with the white elixir colors to the resemblance of silver, seeking that the color may remain while in the fire and may penetrate the whole metal, just as a spirit (*spiritualis substantia*) is introduced into medicines, and in this manner of working it is possible to produce a yellow color, the substance of the metal remaining. And here again it is not to be maintained that several kinds of metals are contained in one another. It is from this and similar things, that is demolished the dictum of those who say that any kind of metal you please is contained in another."

—Courtesy Journal of Chemical Education

ALBERTUS MANGUS

A twentieth century chemistry encyclopedist, J. W. Mellor, speaks enthusiastically of the original contributions of the thirteenth century encyclopedist, Albert, in the field of chemistry:

"Albertus Magnus especially studied the union of sulphur and the metals; and like the Arabian Rhases, he considered the metals themselves to be compounds of different proportions of the three principles or elements: arsenic, mercury, and sulphur. Sulphur, said he, 'blackens silver and burns the metal on account of the *affinity* which it has for these substances'." The term affinity was thus used for the first time to designate the unknown cause of chemical action. Silver was supposed to be the metal most closely allied to gold, so that he considered the transmutation of silver into gold would be the easiest to realize. Albertus Magnus knew how to separate the noble from the base metals by fire, and how to separate gold from silver by *aqua regia*. . . . Sulphur he describes as *substantia uniformis in partibus suis*, which might well mean that it was an element in the modern acceptation of the term; that is, a substance which is chemically indivisible into other substances. If this be so, it must be admitted that Albert, and not Lavoisier, was the first to recognize the elementary nature of sulphur. He also mentions different kinds of sulphur, and the passages suggest that some at least of the allotropic modifications of this element were known to him."

Probably few colloid chemists know that Albertus anticipated Thomas Graham's work, on dialysis. H. Casey, writing in the *Irish Ecclesiastical Record* (1932), states:

"Methods of dialysis, and in fact the phenomenon itself are usually considered as discoveries of Thomas Graham, who flourished during the first half of last century . . . But anyone who wishes to take the trouble of reading the nineteenth chapter of the *Libellus de Alchimia* will find therein an excellent description of dialysis, written at least six hundred years before Graham's discovery of it. St. Albert employed the method of dialysis through a semi-permeable membrane, for the purification of different salts, and with no small success."

In the field of physics and astronomy we find that Albert exercised an immense influence which even affected the course of events in the Western hemisphere centuries later. He accepted Aristotle's theory about the sphericity of the earth, adding arguments unknown to the Greek savant. For example, Albert reasoned from gravitation that all parts of the earth must converge to a center and hence the earth must be a sphere. Contrary to the opinions of certain predecessors, including St. Augustine, he held that there was at least the possibility of land at the antipodes, and said that people living there would not have to stand on their heads as

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Experiences With An Aquarium

● By Sister Angeline, O.S.U.
MOUNT ST. JOSEPH'S JUNIOR COLLEGE, MAPLE MOUNT, KENTUCKY

Sister Angeline states, paradoxically, that maintaining an aquarium is and is not easy. It depends upon how much you know and upon what experience you have had.

If you already know all there is to be learned about aquaria (Who does?), you will enjoy Sister Angeline's experiences. Perhaps you have encountered some of the same difficulties yourself. If you are a novice at the work, this paper will give you some useful information.

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In order to link graphically the real facts of nature with the numerous theories, principles, and laws which the beginner in biology encounters, there should be first-hand study of *living* biological specimens. Observation of the preserved materials, prepared slides, and shipped-in cultures that are so commonly used in schools is not the best method of learning. Neither is the use of such non-living illustrative material necessary, for aquaria and terraria can easily be maintained in our school laboratories. I believe that a fresh water aquarium is essential in bringing to the student the information that he can obtain so directly and so easily by observing the biologic processes, behavior, instincts, and habits of the plants and animals living in it.

The aquarium is one of the simplest and easiest and most interesting projects connected with the biological sciences.

I did not always think so.

Well do I remember how difficult a venture the establishing of our first aquarium seemed. At that time, it really was. First of all, we lacked experience. It was rather an expensive project, for the tank had to be purchased as well as the animals and plants. When we looked into it, the food question appeared to be baffling enough to discourage even the best dietician if we expected to maintain any variety of specimens. In our inexperience we even believed that getting and maintaining a balance of oxygen and carbon dioxide was more or less a trivial and unnecessary detail. We soon learned better.

I thought that after I had obtained the tank and food and the plants and animals—the fish and scavengers—all according to catalog specifications, the big work was ended. In reality, it had only just begun. How beautiful the new aquarium was, teeming with life—but how short-lived it proved to be! I began to feed the fish immediately. But they were timid, and refused to eat. Perhaps, there was a hunger strike. Not one fish accepted food on either the first or the second day. They skimmed the top of the water restlessly, their heads up and their mouths open. Again and again I offered them food. Each time there was the same refusal. If only a few crumbs would float into their wide-open mouths!

Soon, one by one and two by two, my fish turned on their sides, floated for a while, and then found a watery grave. After a few days, only two or three fish shared the aquarium with the newts, the turtles, and the snails, and they remained quiet and still near the bottom of the water. Now when I fed them they would leap up and almost snatch the food from my fingers. How hungry they seemed to be! Many times a day I gave them food and each time they ate greedily and hungrily. Although they were now eating nicely, another and then another died (perhaps from starvation?) and had to be removed from the tank. After two weeks, nothing was left of our "balanced" aquarium but a few stringy plants and a smelly-fishy tank of water.

Such ill luck only stimulated us. Since there must be an aquarium in the laboratory we persevered, and this time we were successful. The new attempt was begun and continued on an entirely different plan. Our technique was entirely experimental. You may care to follow it.

First, place in the tank from one-half to one inch of well washed sand. Then fasten down in the sand a few tips of Elodea, Myriophyllum, Cabomba, and any other water plants that you care to use. The three mentioned are good oxygenators. Sagittaria, Ludwegia, Lemna, and Chara are also good. After the plants have been put in place, fill the tank to within about an inch of the top with tap water or pond water, pouring the water over your hand or a piece of clean white paper so that it will not dislodge the plants that have been anchored in the sand. Place the aquarium where it will get sufficient light, and at least one hour of sun a day. Allow the filled aquarium to stand a day or two before adding the animals.

A few hours after placing the fish and other animals in the tank, put in a half-teaspoonful of salt to every three or four gallons of water. This salt treatment refreshes and stimulates the fish. During the first day or two, watch the tank closely for floaters. Remove them at once and, if they are not dead, place them in a saline solution made by dissolving a tablespoonful of salt in a gallon of lukewarm water. Allow the fish to remain in the solution over night, or until they are again lively and vigorous. When you are to return them to the aquarium, make sure that the water in the two containers is of the same temperature before making the transfer. Close watching will not be so necessary after the first twenty-four hours. The first night is usually the critical time. If all is well

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Atmospheric Electricity And Lightning

● By William A. Lynch, Ph.D., *(New York University)*
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In this instalment Dr. Lynch begins an interesting study of certain electrical phenomena with which the layman is not ordinarily familiar but of which the teacher of science should be informed. In these articles three processes by which electricity is carried between the ground and the upper air are discussed. Lightning is studied in Part II, which will appear in the March number.

The finding of a difficult passage or two in Dr. Lynch's account should stimulate science teachers to further study in the field.

Dr. Lynch will be remembered for his scholarly paper on certain "Aspects of Diamagnetism," which was published in our issue of September, 1936.

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Part I

The atmosphere near the surface of the earth is a region in which mechanical, thermal and optical phenomena occur which are easily observed and evident to everyone.

The only electrical phenomenon of the atmosphere that is recognized readily by the layman is that associated with thunder storms; and yet even on a clear, sunshiny day the atmosphere is abounding with electrical disturbances. Radioactive elements are disintegrating, ionizing radiations are sweeping through the air, ions are being generated and destroyed, and continuous currents are flowing between upper atmosphere and ground. In fact, the whole atmosphere on such a day behaves as though it were a huge, leaky condenser with the upper regions the positive plate, the earth below the negative plate, and the air in between the dielectric. The dielectric, however, is not a perfect insulator but has a very low conductivity so that some current flows constantly through the dielectric medium. This current to unit area of the earth's surface is very small and can only be detected by sensitive apparatus, but it reaches the value of about 1,000 amperes when the whole surface of the earth is considered.

The questions immediately arise of how the air acquired its conductivity, and why the condenser is not discharged in a comparatively short time, and how the charges are replenished continuously. These are the main problems of atmospheric electricity. In order to answer them we shall have to study the electrical properties of air, the electricity of fair weather and stormy weather, and finally, the origin and nature of thunderstorms. When we have finished, we shall have some insight into the complicated electrical character of the surrounding atmosphere.

CONDUCTIVITY OF THE ATMOSPHERE

A gas conducts electricity when it contains ions or carriers, and is exposed to electrical forces that urge the positive ions in one direction and the negative ions in the opposite direction. Ionization of a gas is produced by the energetic action of an ionizing agent which succeeds in tearing an electron away from a molecule of the gas. It leaves behind a positively charged nucleus which becomes the positive ion. The liberated electron usually gathers to itself a neutral molecule which then becomes the negative ion. In the atmosphere many of the ions are of this type. They are of molecular magnitude, carrying a single elementary charge, either plus or minus. They are called the "small" or "fast" ions, and have a mobility, i.e., velocity in unit electric field, of 1.5 cm./sec. per volt/cm. which corresponds to the mobility of the ions measured in dry air in the laboratory.

In addition to these, are the "large" or "slow" ions which are composed of comparatively massive bodies acting as nuclei to which small ions have attached themselves; these slow ions have a mobility of only .0003 to .0005 cm./sec. per volt/cm. The bodies that act as nuclei are small particles of dust or smoke or very small drops of water; they are called condensation or Aitken nuclei. Whenever condensation nuclei are available in large quantities, the slow ions greatly exceed the fast ones in number. Over land there may be from 1,000 to 80,000 large ions per c.c. and only from 300 to 1,000 small ions per c.c. The large ions are formed at the expense of the small ones. Over the sea, on the other hand, condensation nuclei are lacking, so that the small ions number from 500 to 700 per c.c. and the large ions only about 200 per c.c.

When these ions are exposed to an electrical field they move in one direction or the other, depending on their sign; and the gas is said to be conducting or to possess conductivity. The total flow of electricity is determined by the sum of the four streams of ions, two positive and two negative. Each stream moves at a rate determined by its mobility and the strength of the electric field in which it is situated. Usually the small ions are the more important for they have the greater mobility and, although less numerically than the large ions, transfer more electricity across an area in a second than do the large ions. For example, suppose there are in the atmosphere 500 small ions per c.c. with a mobility of 1.5, and 1,500 large ions per c.c. with a mobility of .0004. The contribution of the small ions to the conductivity will be measured by 500 x 1.5, while that of the large ions will be 1,500 x .0004. That is, the fast ions are more important than the slow, in the ratio of 1,250 to 1. If we take the extreme values given above, 1,000 per c.c. for the small ions and 80,000 per c.c. for the large, then the effect of the slow ions

is appreciable in determining the conductivity of the atmosphere; these numbers hold for the vicinity of a large city, and the contribution of the slow ions would be about one-fifth of that of the fast ions to the conductivity.

IONIZING AGENTS

The chief agents of ionization in the atmosphere are three in number: radioactive substances in the earth, radioactive gases in the air itself, and radiations from exterior space called the penetrating radiation or cosmic rays. It is interesting and important to estimate the contribution each of these agencies makes to the total conductivity. The surface layers of the earth contain radium and other radioactive substances which are continually giving off α, β and γ rays. The α rays are the least important of these, as they have a very small penetrating power and are stopped by very thin layers of solid matter, or by a few centimeters of air at atmospheric pressure. The β rays have greater penetrating power and can, therefore, reach the atmosphere from deeper layers in the earth and proceed a greater distance into the atmosphere, ionizing as they go. They produce about 1 pair of ions per c.c. per second, on the average, at the surface of the earth. This number is reduced to 1/10 at a height of 10 meters, so that on the whole the β rays are only a weak ionizing agent. The γ rays are the most important of these rays. They produce about 3 pairs of ions per c.c. per second at the surface, 1.5 pairs at 150 meters, and 0.3 pair at 1,000 meters. Sea water contains very little radioactive material as compared to that in the soil and rocks of the land, so that radiations from the ocean into the atmosphere are negligible.

The air contains emanations from the radioactive substances in the earth. The most important of these is radon, the heavy, inert gas that results from the disintegration of radium. Radon in turn disintegrates with a liberation of α particles which are very effective in this instance as they are in direct contact with the air. About 5 pairs of ions are formed per c.c. per second near the earth's surface by this means; the effect decreases with height, so that at 5,000 meters it is only about 2% of the surface value. Over the ocean the effect is practically zero as the radon present in the atmosphere there is only about 1% of what it is over the land.

The third agent is perhaps the most interesting of all. Controversy is still raging over the origin and nature of the cosmic rays, but we need consider only the ability of the rays to produce ions, and there is no question about their properties in this respect. The rays come downward to the earth and have a penetrating power far greater than the most penetrating γ rays known; they produce from 1.5 to 2.5 pairs of ions per c.c. per second at the earth's surface. The effect increases with height, as is to be expected if the rays come from exterior space, so that it is 10 times greater at 5,000 meters than at the earth's surface. Furthermore, the rays are just as effective over the ocean as over the land; so they constitute practically the only ionizing agent over the sea. It is now evident that, when both the upper and the lower regions of the atmosphere over the whole earth are considered, the penetrating radiation* is the most important agent of all in making the air a conductor.

Although ions are formed continuously as a result of the action of the ionizing agents, the number does not increase indefinitely because of the ability of the ions to diffuse and to recombine. Ions diffuse in the same manner as do uncharged molecules of the air and give up their charges when they come in contact with the earth or other surroundings. They combine, too, with one another to form a neutral aggregation once more. The rate of recombination depends on the gas pressure and the type of ion. It has been measured carefully by laboratory experiments. But the small ions may lose their effectiveness in determining the conductivity of the air, even though they are not actually removed as ions. If they are converted into large ions, they contribute only a very small part to the total conductivity, except in extreme cases. The condensation, or Aitken nuclei, play an important part in determining the ion balance by capturing small ions and reducing their mobility to that of the large ions. In the atmosphere in fine weather, a state of equilibrium is reached between the rate of generation of the ions by the ionizing agents and the rate of disappearance of the ions due to the agents of removal. The number of ions actually present per c.c. remains essentially constant after the equilibrium condition has been attained. When ions are subjected to an electric field, they move with a velocity determined by their own mobility and the strength of the applied field. A field is present in fine weather which urges the positive ions downward toward the earth. We proceed to the study of this field which is usually designated the fine weather field.

THE FINE WEATHER FIELD

The following experiments on the measurement of the earth's field are fundamental in this study and will serve to clarify our ideas about electrostatic charges and fields in general; the principles only are given, but the details have been very carefully worked out, particularly by C. T. R. Wilson in England. Suppose a circular metal plate P, Fig. 1, to be mounted level with the ground and insulated from it, in an open field free of trees or other projections. The plate is surrounded by a grounded guard ring R, and connected to a sensitive electrometer E sunk in a pit below P; E is surrounded by a metal case D raised to a positive potential by battery B_1. A variable condenser C is connected between the moving system of E and the negative side of a battery B_2 as shown; a metal cover S is provided which may be placed over P as shown by the dotted line, thereby shielding P from external electrostatic influences. A grounding key G is available for bringing P and the moving system of E to ground potential; various shields are also used to prevent undesired mutual electrostatic effects. These are not shown.

To measure the earth's charge, S is placed in position over P; E and P are grounded by closing G momen-

*For further details about the penetrating radiation, see a very interesting little book by H. B. Lemon, *Cosmic Rays up to Now*.

tarily and the deflection on E is read. There will be a deflection of E because of the appearance of a negative charge on the leaves; for it has been brought to zero potential by grounding, while surrounded by a positive conductor D. S is removed and P exposed to the earth's field; the setting of C is zero. A negative charge is induced on P by exposure to the downward

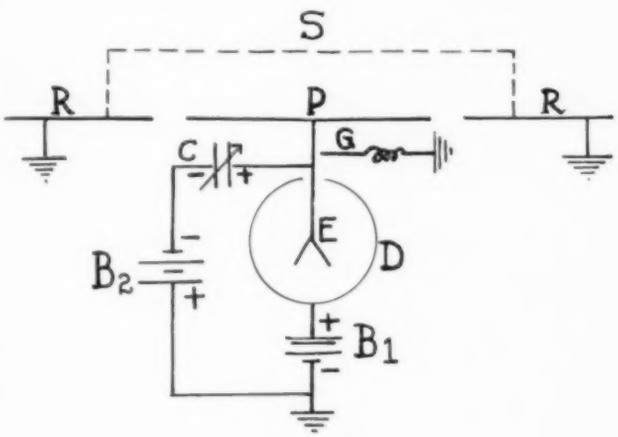


FIGURE 1
APPARATUS FOR WILSON'S METHOD OF MEASURING SURFACE DENSITY OF EARTH'S CHARGES

directed field, and a corresponding positive charge appears on the leaves of E; the deflection of E therefore decreases. The condenser C is now increased from zero capacity up to the value C such that sufficient positive charge is withdrawn from E to bring the leaves back to the ground potential reading; this positive charge appears on the positive plate of C and is equal in magnitude to the negative charge induced on P by the earth's field. Hence the value of the charge on P is $-CV$ where V is the voltage of B_2; if A is the area of P, the surface density of charge σ on P is $-\frac{CV}{A}$; this is also the surface density of charge on the earth itself. The average value of the surface density of charge on the earth in fine weather is 2.7×10^{-4} e.s.u. per sq. cm., or .0009 coulomb per sq. km; the entire charge over the whole surface of the earth amounts to about 500 000 coulombs.

When the surface density of charge on an extended plane conductor is σ, the electric field in the vicinity is $4\pi\sigma$; the charge on the earth is negative so this field is directed downward toward the earth. The downward direction is considered positive when discussing the earth's electric field. From the above measurement of σ, we find that the magnitude of the earth's field is approximately 100 volts per meter; this quantity is also called the potential gradient of the field and shows by how much the electrical potential changes as we move vertically upward from the earth. Thus, in fine weather, a point one meter above the surface is 100 volts higher in potential than the earth itself; a unit charge, 1 coulomb, at this point has 100 joules more energy than a corresponding charge on the surface. Positive charges are urged toward the earth because of this excess of electrostatic energy; as the positive ions move they constitute the current of the fine weather field directed to the earth.

A more direct method of measuring the earth's potential gradient is that first used by Beccaria in 1775, who stretched a wire horizontally between non-conductors and measured its potential with respect to the ground by means of an electrometer. A wire mounted in this way comes to the same potential as the surrounding air; if originally at a different potential, charge flows to or from the wire until the potentials of air and wire are equalized. In order to hasten the attainment of equilibrium, some form of "collector" is fastened to the center of the wire which increases the conductivity of the air in the immediate vicinity. Often a small piece of metal covered with a deposit of radioactive material is used. The wire is then able to follow rapid changes in the potential gradient, such as occur in thunderstorms. The electrometer measures the difference in potential between the earth and the air at the height of the wire; this difference in potential, divided by the height, gives the potential gradient of the field there.

A modification of the horizontal wire apparatus uses Lord Kelvin's water dropper as a collector to keep the

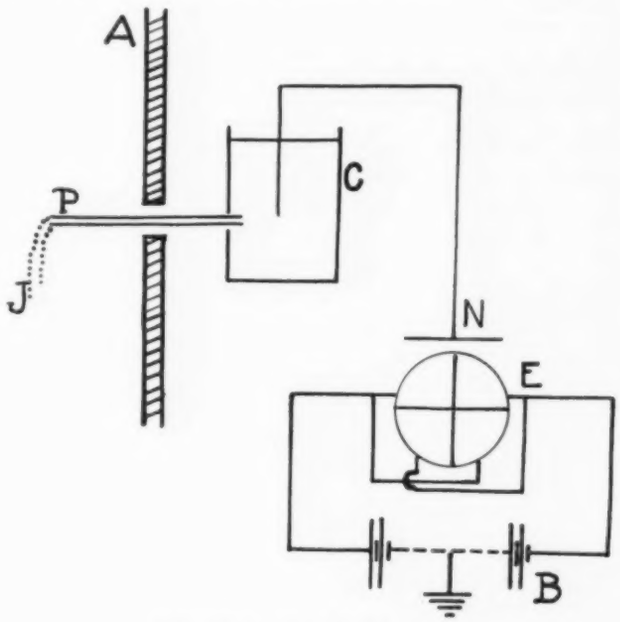


FIGURE 2—*(Not drawn to scale)*
KELVIN WATER-DROPPER FOR MEASUREMENT OF EARTH'S POTENTIAL GRADIENT

A—WALL OF BUILDING
P—INSULATED PIPE
J—JET OF WATER
C—INSULATED TANK OF WATER
N—NEEDLE OF ELECTROMETER
E—QUADRANT ELECTROMETER
B—BATTERY GROUNDED AT MIDPOINT

conductor at the same potential as the air; the water dropper is used generally when a continuous record is desired. At such a station an insulated metal tube projects horizontally from the side of a building; one end is connected to an insulated cistern within the

Continued on Page One Hundred and Twenty-six

You Should Read

●

Essentials of College Chemistry

● *By* G. H. WHITEFORD and R. G. COFFIN, professors of chemistry at Colorado State College; C. V. Mosby Co., St. Louis. 1937. 514. Illustrated. $4.00.

This college text is intended to serve the needs of beginning students, grounding them thoroughly in the use of basic chemical principles without burdening them with too many factual details. It is designed for the use of chemistry and non-chemistry majors. For the latter, it will provide a survey of the science.

Historical considerations have been minimized on the ground that the beginning student does not fully appreciate the problems of the research scientist, a procedure that is at least debatable. This reviewer is of the opinion that the historical approach can be used very effectively. Surely students should be made to realize that they are studying a living, growing, and progressing science and that everything worth while knowing has not yet been discovered, and that many famous chemists are not only alive but hard at work every day endeavoring to extend the boundaries of our chemical knowledge.

The authors are to be commended for stressing the fact that problems based on weight relations can be solved without using a proportion. The section on organic chemistry might have been extended to include at least some study of foods. Consecutive and concurrent reactions are not mentioned in the text but they are employed in the balancing of equations for oxidation-reduction reactions. However, the valence-change method of balancing is also shown. The most recent work on isotopes, and heavy water, and the Brönsted theory of acids and bases are not included.

The book is well made and the text is clear of typographical errors. Thirty-two line drawings are used to illustrate the text.

Teachers of high school chemistry and their more advanced pupils will find this text of value for reference. *J.F.M.*

◆

General Biology

[2nd Edition, 1937]

● *By* E. GRACE WHITE, Professor of Biology, Wilson College, Chambersburg, Pa. C. V. Mosby Co., St. Louis. 667. 336 illustrations. $3.00.

To review a textbook fairly the reader must first consider it from the author's point of view. What is the purpose or goal of the book? Does the technique of approach make the achievement of the goal a reasonable certainty?

The substance in a given field cannot vary greatly in different texts; therefore, the writer's chief contribution lies in the selection and organization of its material. If the organization seems likely to fulfill the purposes conceived by the author, the book must be judged as good.

Dr. White wants her book to help the student "to an understanding of life as an organic whole by first observing known types of life." She believes that this is best accomplished by "first observing known types of life, which can easily be compared with one's own experience," (rather) "than by a study of the cell which is a comparatively unknown field."

Miss White has consistently and ably developed her book toward this goal in three major divisions: I. The Unity of Life; II. Problems of Biology; III. Progressive Development.

Plant and animal lore are dealt with on more nearly even terms than is usually the case in "Biologies." The subject matter is up to date and clearly presented. For those who are willing to assign chapter readings out of the presented sequence, the book will seem unusually flexible. The historic approach to the Problems of Biology develops them as they are, either satisfactorily solved or as matters still to be worked over.

The book is well illustrated, many of the plates being original. The type face and format produce an attractive page that is very easy to read. The paper and binding do full justice to the work of the typographer.

Having judged the book from the author's viewpoint, a reviewer may then decide whether or not he personally likes the method of organization and why.

I was brought up on much the same philosophy of biological pedagogy as Dr. White has subscribed to in her book and I have adhered strongly to it for many years. However, I am slowly being forced to change my ideas of presentation through two experiences. The first has come through watching students, regardless of the text advised, purchase books that presented biological facts in phylogenetic succession. The second is that teachers themselves choose more frequently the "phylogenetic" books than they do books that I have considered superior.

The reasons for these apparent preferences may lie in the student's ability to grasp more readily small but complete units of information about a single form than he does a general principle. Teachers may realize this or, when they themselves are not broadly trained, find it easier to keep ahead of the class when today's exercise can be learned without reference to what is to follow.

One more point! Neither student nor teacher, irrational as it may be, likes to skip about through the book. They like to begin on page one. Dr. White has very reasonably arranged her book with the possibility in mind of the reorganization of its contents by its users. This very possibility may not meet with the approval of many teachers.

I really think that Dr. White has turned out an excellent book and that the publishers have contributed much to its quality. It deserves to take its place among the several good books on biology now available. Whether or not it receives the recognition due it will depend on how many teachers (and students) still want to start with unicellular organisms and proceed up the tree of life in orderly fashion through one multicellular branch after another. If the latter method is done with ordinary skill they will at least come to know the tree; if well done the forest is apt to become as visible by this method as by any other. And what biologist would deny them this expression of personal variation?

ROBERT T. HANCE,
University of Pittsburgh.

Pictures Through The Microscope

● **By Edmund A. Yochum**
ST. JUSTIN HIGH SCHOOL, PITTSBURGH, PA.

In this article, a high school senior student tells how photomicrographs can be made with an ordinary microscope and a home-made camera.

The accompanying pictures show the simplicity of the apparatus and the character of the work that can be done with it even by an amateur. The cross-section cuts are reduced one-half.

Perhaps one of YOUR *students can be interested in this profitable and fascinating work.*

●

Often it is difficult to describe to some one the things we have seen under our microscope. It is even difficult to point out to another a certain part of what is on the slide while the slide is still under the microscope. But if we can take a picture of what we see, if we can record and even enlarge it by photography, our difficulties are for the most part solved.

Such photomicrographs (*not* microphotographs), as these pictures are called, are not difficult to take even with improvised apparatus. Two illustrations which accompany this account were reproduced from photomicrographs taken with a home-made camera used in connection with an ordinary compound microscope such as is found in the science department of every high school.

A camera need not be constructed if a regular camera is available. In that case its focussing scale is set at 100 feet. We have obtained just as good or better results, however, with a home-made camera. This camera is merely a light-proof box, not unlike a common fixed-focus box camera, except that it has no lens. There is merely an aperture fitted with a felt gasket that slips on or over the eye-piece of the microscope, the gasket serving to make a light-proof joint. The back of the box is constructed so as to accommodate a 4" x 5" plate holder which fits into a slide to which are attached strips of felt to exclude light. The camera is fastened with movable clamps to a metal ring-stand so that the camera will be held rigid while it is in use and so that it can be lowered to or raised from the eye-piece of the microscope.

A brilliant, concentrated light is carefully focussed on the mirror of the microscope. We have found that an automobile headlight bulb fitted into a tube supplied with a bull's-eye lens from a flashlight, and operated from proper voltage through the transformer of an ordinary toy railroad train, gives good illumination.

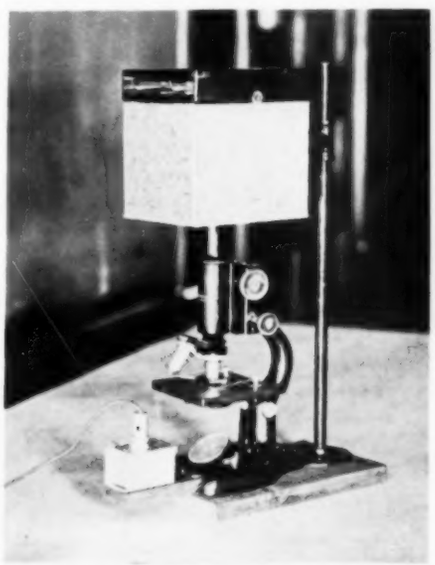
When the apparatus has been assembled, a sheet of ground glass or, better, an undeveloped photographic plate of the right size, is inserted into the slot provided for the plate holder. The microscope holding the slide is then focussed until the image is sharply defined on the ground glass. The glass is then removed and the plate holder and plate are inserted. An ordinary or orthochromatic photographic plate or cut film will give excellent pictures, but more contrast and better definition will be obtained if special photomicrographic plates are used.

The exposure is made by timed illumination. The duration of the exposure will depend upon the brilliance of the light and the comparative density or clarity of the slide. An average exposure, using a 450 power microscope, is about three seconds.

Better results can be gained by using a colored light filter under the slide. When standard gelatin filters are not available, pieces of red, blue, or green cellophane will serve. Contrast and definition are improved by using a filter of a color that contrasts with the color of the stain. When a red filter is employed, a special "microphoto" plate, or a panchromatic plate,

Continued on Page One Hundred and Twenty-Two

CROSS SECTION OF EARTHWORM



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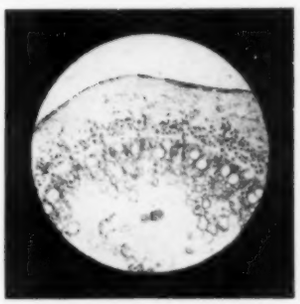

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Sensory Experiences

Continued From Page One Hundred and Five

complexity of numerous scientific phenomena. But, the indiscriminate use of either technique in any specific class situation may bring unsatisfactory results in learning.

It is common knowledge that, in certain schools, students pursuing courses in science are herded into large rooms at periodic intervals to be exposed to scientific films. The motion pictures may or may not have a relationship to the present unit of work or to the tasks and projects that are to follow.

Proponents of the idea believe that mere exposure to a visual stimulation is sufficient to promote constructive thinking within the cerebral mass of the individual affected, but evidence does not exist to prove this contention. Under mismanagement of this sort, instructional films will be looked upon as just so many "movie shows." Youngsters will react to them in a manner similar to that exhibited at the commercial theatre.

With a little foresight on the part of the teacher, combined with a carefully organized plan, sound and silent motion pictures of the 16 mm. variety can aid the student to achieve a co-ordinated impression of any worthwhile scientific fact, principle, or phenomenon. A few simple suggestions may be helpful.

1. Choose films only after consulting descriptive literature that outlines major emphases. Then complicated treatments of simple subjects may be avoided. Titles are misleading.
2. Arrange to have distributors forward films so that they will correlate with your program and method of instruction. A motion picture projected too early or too late in a course of study may interfere with the proper acquisition of scientific relationships.
3. Project films before exhibiting them to class groups. Instructors should know just what points to stress and clarify.
4. Allow students to raise questions during the actual projection of the film as well as at the end.

Among the best 16 mm. films suitable for use in high school courses in general science, biology, chemistry, and physics are those produced or distributed by the following concerns:

Metropolitan Life Insurance Co., 1 Madison Avenue, New York City ..... Biology
Castle Film Co., Rockefeller Center, New York City ..... General Science, Biology
American Museum of Natural History, New York City ..... All Sciences
General Electric Co., Philadelphia, Pa. ..... Chemistry and Physics
U. S. Bureau of Mines, Forbes Street, Pittsburgh, Pa. ..... Chemistry and Physics

The advertising material in most of these motion pictures has been reduced to a tolerable minimum, and the subject matter can be easily correlated with a variety of course outlines.

By reason of its nature, the radio offers many salient auditory stimulations of spontaneous origin. If the Piccards decide to make an ascent into the stratosphere, or if Dr. Beebe undertakes another undersea excursion in his bathysphere, one or more of the national networks may arrange, at short notice, to air the happenings. Unless the science teacher watches closely the radio columns of the daily press, or listens to the announcements of daily features on the air waves, many programs of scientific interest possessing stimulating attributes will be missed. Often it is the spontaneity of a radio offering that creates such an intense appeal. A few of these auditory stimuli will do little harm to a course of study. Whereas, a motion picture portrays past occurrences, a radio and a school journey bring us closer to our environmental surroundings while they are functioning, and tend to make our learning experiences more concrete.

◆

Aquarium

Continued from Page One Hundred and Twelve

the next morning, there is probably little danger ahead, so far as the water of the aquarium is concerned.

The time of the first feeding is most important. Do not feed the fish until the third or fourth day. Then stand by the tank quietly, dropping in the food slowly in very small quantities. Touch each floating particle, a piece at a time, so that it will become wet and sink slowly. The fish will dart at it and get it as it sinks. In order to simplify matters, I feed all aquatic animals on the same diet, raw oatmeal. They relish it and thrive on it.

Feeding time should come only once every three or four days. Feeding once a week is much safer and better than once a day. More fish are killed by overfeeding than by starvation. It is a good plan to give only sufficient food at each feeding, so that there will be little or no food remaining uneaten. If much food is left, it will ferment and acidulate the tank. An aquarium ball, which may be purchased at any dime store, may be placed in the water, but it is really necessary only for the first few weeks during the balancing process.

In order to insure a wholesome habitat for aquarium animals, the artificial environment must duplicate the natural as closely as possible. Do not disturb the aquarium any more than is necessary. Add only enough water to make up for the loss caused by evaporation. Occasionally, siphon off the refuse matter from the bottom of the tank. Then, if the aquarium is well balanced, it will be as clear after years of use as it was during the first week.

◆

EXHIBIT

Corning Glass Works will exhibit many new items in "PYREX" Brand Laboratory Glassware, together with displays of standard items, complete units of laboratory apparatus and equipment for industrial applications at the sixteenth annual Chemical Exposition, Booth Nos. 332-333-346-347, Grand Central Palace, New York City, December 6th to 11th.

Experiment Station

Continued from Page One Hundred

als, principally coal. Analyses are made of such materials as coal ash, slags, clinkers, boiler waters, and rock dust used for the prevention of coal-dust explosions in mines. Investigations are made leading to standardization of methods of analysis of coal and coke. Standardization of the agglutinating-value test for coal is under way, and in general all small-scale laboratory tests having to do with gas, coke and byproducts of coal are made in this section. One important phase of the work has been the development of a standard classification for coals based on chemical analysis; this work has been done in cooperation with a committee of the American Society for Testing Materials.

MISCELLANEOUS FACILITIES

So wide a variety of research could hope for little progress without the support of a well-balanced shop personnel. The station has its own machine, carpenter, instrument, and glass-blowing shops, and an electrician and plumber are always at hand. Naturally, considerable stocks of chemical and other supplies must be kept at all times.

Today a research worker is badly handicapped without library facilities, and the station maintains its own technical library of reference works, current periodicals, texts, and handbooks.

Photography and drafting are cared for by the graphic section, which prepares the many photographs, drawings, and lantern slides used for publications, reports, lectures, exhibits, and loan to the public. It also operates the Bureau's motion-picture loan service. The photographic files contain over 47,000 negatives, and approximately 1,400 sets of motion pictures on industrial and safety subjects are available for free loan to public groups and schools.

There is also a duplicating section for multigraphing or mimeographing all reports of investigations, information circulars, and miscellaneous circulars, forms and pamphlets issued by or used in the Bureau.

The station is always open to visitors who have a genuine interest in the work being conducted, but, obviously, the work is not such as to furnish an attraction to the casual sightseer. To those engaged in work touching on the lines of research pursued, a cordial invitation to visit the station is given.

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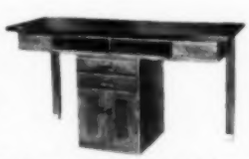

Biology and General Science Table No. BL-30

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Some Demonstration Aids

Continued from Page One Hundred and Two

the ice to form H_2O_2. The peroxide oxidizes potassium iodide, liberating free iodine which turns starch blue.

4. Products of Oxidation—Students are always interested in the demonstration that their own bodies produce the same products of oxidation of carbon and hydrogen as are formed in the burning of gas, coal, or wood. By holding a beaker of ice water in a gas flame, water is condensed upon the outside of the beaker; the same result is obtained by breathing upon the beaker of cold water. By inverting a beaker over a flame for a moment and then adding to the beaker some solution of barium hydroxide, CO_2 may be demonstrated; likewise by exhaling through barium hydroxide solution, $BaCO_3$ is formed.

"Dry Ice" may be obtained from almost any drug store. It is a most convenient source of CO_2 and for obtaining low temperatures. If in an inclined trough several lighted short lengths of candle are placed at different levels and a block of dry ice is placed at the upper end of the trough, the candles will be extinguished in succession as the heavy CO_2 flows downward.

SURFACE TENSION

1. Surface Conditions Differ From Interior Conditions in Liquids—This fact is convincingly shown by floating a needle upon the surface of water.

2. Surface Tension Operates to Diminish the Surface—If two soap bubbles of different size are connected through a tube, the smaller bubble flows into the larger one since the total surface is thereby diminished. A T-tube connecting two bent glass tubes which have been flared at the ends makes a convenient apparatus for this demonstration. A satisfactory formula for the soap solution is the following: 10 ml. of oleic acid, 76 ml. of glycerin, 54 ml. of water, 32 ml. of Normal ammonium hydroxide.

3. Effect of Electrical Charge Upon Surface Tension—When mercury is placed in dilute sulphuric acid the mercury surface becomes charged with positive electricity, a potential of about 0.9 volt being produced. Hence, the surface tension of mercury is decreased when it is brought into contact with dilute sulphuric acid. Place enough mercury in a small porcelain dish or watch glass to cover a patch about the size of a silver quarter. The mercury must be bright and clean; it may be cleaned by filtering through chamois or through a pin hole in dry filter paper. Cover the mercury with dilute H_2SO_4 (1:10) which contains just enough potassium dichromate to impart a light yellow color. The drop of mercury flattens out when the acid is added, proving that its surface tension has decreased. Now touch the mercury with an iron wire which has been cleaned with ntiric acid, and observe that the mercury contracts suddenly, signifying an increased surface tension. The iron wire dissolves slowly in the acid going into solution as ions with positive charges. This leaves the wire negatively charged, and it is this negative electricity which goes over to the mercury. Fix the wire in such position that the contraction breaks the contact. As soon as the contact is broken the mercury flattens out once more, but thus comes into contact with the wire and promptly contracts again. A rhythmic pulsation of the mercury is obtained.

4. Effect of Solute Upon Surface Tension—Drop a small bit of solid camphor upon the surface of pure water in a perfectly clean dish. The camphor darts about on the surface until by its solution in the water it has lowered the surface tension of the latter a certain amount. The explanation of the movement of the camphor is that by the dissolving of a little of the camphor under the piece there is a local lowering of surface tension, so that the surface yields at this point and is stretched by the greater tension of the surrounding surface. This jerks the camphor away with it. If the camphor is attached at the end of a small celluloid boat, the latter is propelled on the surface. If a glass rod is touched to the skin of the nose and then touched to the water, the movements of the camphor particle immediately cease. The minute amount of oil from the skin, provided the skin has a normal amount of oil, is sufficient to lower the surface tension of the water to a point where the dissolving camphor cannot lower it further.

MISCELLANEOUS

1. Frauenhofer Phenomenon—A gas absorbs light of the same wave lengths it emits when made luminous. This fact accounts for the dark lines in the spectrum of the sun and other stars (Frauenhofer Lines), and permits the identification of elements present in these bodies. The phenomenon may be demonstrated impressively without the use of a spectroscope in the following simple way. With a sodium flame as a background against a white screen, a second sodium flame is interposed between it and the observer. The fringes of the second flame, where the sodium gas is somewhat cooled, appear dark or sooty.

2. Radioactivity—The spinthariscope (Central Scientific Co., No. 71205, $4.00) affords a beautiful demonstration of atomic disintegration. After having been in a completely darkened room for several minutes one may clearly see the innumerable flashes of light which represent the impact of alpha particles from radium atoms.

3. Double Refraction—In demonstrating double refraction it is convenient to place the Iceland Spar crystals (Central Scientific Co., No. 87595, $0.50) over a pinhole in a screen covering a source of bright light.

4. Polarized Light—With a pair of Polaroid discs (Central Scientific Co., No. 87602, $10.00) all of the essential principles involved in polarized light, optical activity, and the use of the polariscope may be demonstrated.

5. Law of Conservation of Mass[1]—Put about 25 ml. of water into a wide-mouth 20-oz. glass bottle. With

[1] These two simple and effective demonstrations have been devised recently by Dr. E. F. Williams in this department.

forceps or tongs introduce a small, squat, wide-mouth bottle half-filled with concentrated potassium hydroxide solution. The smaller bottle must be taller than the diameter of the larger bottle, so that it cannot fall over and spill its contents. Next, carefully set in upright position in the water of the larger jar a small, flat-bottom vial containing concentrated hydrochloric acid. Drop into the water two or three pieces of limestone, about 5 grams in all. Now replace the air in the system with CO_2; this may be done most easily by dropping a bit of "dry ice" into the water. Finally stopper the large bottle with a tight-fitting rubber stopper and place on a balance sensitive to 0.1 gram. Weigh carefully. Remove the bottle, tip over the vial containing the acid, and replace on the balance. No change in weight occurs as the limestone reacts with the acid and apparently is destroyed.

6. **Law of Multiple Proportions**[1]—An understanding of the law of multiple proportions and the calculation of molecular formulas from analytical data may be facilitated by the use of small metal balls of uniform weight. Lead shot (Remington Red Top Air Rifle Shot) and steel shot (American Ball Company Copprotect Shot No. 5) are satisfactory. Ascertain the average weight in milligrams of a single shot by weighing a sufficient number. Any mixture ("compound") of the lead and steel shot may then be "analyzed" by obtaining the total weight, then removing the steel shot with a magnet, and finally weighing the remaining lead shot separately. Percentage figures are thus obtained from which the "formula" may be calculated. The calculation may be checked by actual count of the shot.

Microscope Pictures

Continued from Page One Hundred and Seventeen

must be used since the ordinary plate is insensitive to red light.

The camera set-up used for photomicrographs can be used for making tracings or drawings of projected images. When a thin paper is placed over the ground glass used for focussing, a tracing is easily made.

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A Technique Of Study

Continued From Page One Hundred and Seven

3. Bleaching with chlorine is an oxidation process.
4. Metallic silver is readily soluble in hydrochloric acid.
5. True combustion can occur in the absence of oxygen.
6. Hydrogen chloride is a greenish yellow gas.
7. Iodine can be separated from graphite by distillation.
8. An aqueous solution of H_2F_2 is an electrolyte.
9. The formula of fluorite is CaF.
10. Bromine is the by-product of the manufacture of caustic soda.
11. Fluorine is less poisonous than chlorine.
12. Cryolite is used in the manufacture of aluminum.
13. Chlorine is more soluble in water than hydrogen chloride.
14. AgBr is used in the manufacture of photographic films.
15. Chlorine is easily liquefied.
16. Bromine is more active than fluorine.
17. Silver chloride is soluble in nitric acid.
18. Silver chloride is soluble in ammonium hydroxide.
19. Chlorine is used for bleaching silk.
20. Manganese dioxide is an oxidizing agent.
21. Chlorine is used for the disinfection of rooms.
22. Hydrogen chloride is found in volcanic gases.
23. Hydrochloric acid is used in the manufacture of glucose.
24. The iron and steel industry consumes ½ of the hydrochloric acid output of the United States.
25. Chlorine is less active chemically than oxygen.

Section II

RECALL EXERCISES

DIRECTIONS: Certain words, symbols, or formulas have been left out in the sentences given below. A blank line shows where the omissions occur. You are to write on the blank the word(s), symbol(s), or formula(s) which have been left out. Your score for this part will be 1 for each correct response.

1. The color of the chloroform solution of Br is _____.
2. Thirty grams of water will dissolve _____ gram(s) of Br.
3. The formula of cryolite is _____.
4. The most abundant compound of Cl is _____.
5. The stability of the hydrogen compounds of the halogens decreases as their atomic weights _____.
6. Chlorine reacts with water forming _____ and _____.
7. All the halogens have _____ electron(s) in the outer shell.
8. A very delicate test for iodine is the _____ color when it is adsorbed on _____.
9. $KClO_3$ is formed by the electrolysis of _____.
10. One ml. of water at 20° C. will dissolve _____ ml. of Cl.
11. Tincture of iodine (U.S.P.) is made up of _____ g. of KI, _____ ml. of water, _____ g. of I, and _____ sufficient to make the total volume one liter.
12. _____ is necessary for the proper functioning of the thyroid gland.
13. Chlorine has no action on _____ or upon any other form of carbon.

Section III

MULTIPLE RESPONSE EXERCISES

DIRECTIONS: In each of the following statements you will find a number of responses only one of which is correct. *Underline* the correct response and place its number in the blank at the left of the statement. *Do not underline more than one response.* Your score for this part will be 1 for each correct response.

1. The gastric juice normally contains (1) 02.50%, (2) 00.25%, (3) 25.00%, (4) 00.025% of hydrochloric acid.
2. The principal valence of the halogens is: (1) 1, (2) 3, (3) 5, (4) 7.
3. (1) Priestley, (2) Solvay, (3) Scheele, (4) Lavoisier, discovered chlorine.
4. The color of the CCl_4 solution of I is (1) brown, (2) blue, (3) purple, (4) red.
5. Bromine is a: (1) solid, (2) liquid, (3) gas, (4) colloid.
6. Sea water contains (1) 00.30%, (2) 40 parts per 1,000,000, (3) 70 parts per 1,000,000, (4) 65 parts per 1,000,000 of bromine.
7. "Glass ink" contains: (1) $NaHF_2$, (2) NH_4HF_2, (3) KHF_2, (4) CaF_2.
8. The boiling point of hydrogen fluoride is: (1) 20° C., (2) 68° F., (3) 19° C., (4) 37° C.
9. By far the most important compound of iodine is: (1) AgI, (2) NaI, (3) KI, (4) NH_4I.
10. The commercial source of chlorine is: (1) KCl, (2) NH_4Cl, (3) NaCl, (4) $CaCl_2$.
11. The atomic number of iodine is: (1) 9, (2) 35, (3) 53, (4) 17.

Section IV

MATCHING EXERCISE

DIRECTIONS: In this matching exercise, you are to number the item in Column I to correspond to the item in Column II with which it is *directly* associated in meaning. Do not use a given number more than once. Your score for this part will be 1 for each pair correctly matched.

COLUMN I	COLUMN II
_____ Cl.	1. Isolated F.
_____ Davy.	2. Discovered Br.
_____ KI_3.	3. Matches.
_____ Hydrofluoric acid.	4. Magnalium.
_____ Balard.	5. Proved I to be an element.
_____ $NaHF_2$.	6. 4 per 100,000.
_____ Courtois.	7. A sedative.
_____ KBr.	8. Anti-knock gasoline.
_____ Moissan.	9. Cretinism.
_____ Hydrochloric acid.	10. I dissolved in KI solution.
_____ I.	11. Deliquescent.
_____ NaI.	12. Insecticide.
_____ Br.	13. Muriatic.
	14. Discovered I.
	15. Etches glass.

Albertus Magnus

Continued From Page One Hundred and Eleven

was asserted, for such things as Orient and Occident, upper and lower, right and left were only relative terms, and that, consequently, the motion of heavenly bodies on the supposed continent would be identical with that in Europe itself. Schwertner relates:

"This cosmographical teaching was traditional in Dominican schools for centuries . . . Hence it comes that Albert's theories were taught to Dante by his Dominican professor, Fra Remigio de Girolami, and that they appear prominently in the tenth canto of the *Paradiso*. This also accounts for the reverential mention of Albert by the great Florentine poet.

"So, too, the man whose name was attached to the western hemisphere, Amerigo Vespucci, got his cosmographical ideals at San Marco, Florence, from his uncle, the Dominican George Anthony Vespucci. That these ideas were in the air when Columbus was seeking support for an expedition to the Indies is plain from the poem *La Sfera* of Leonardo Dati, which reproduced faithfully the teaching of Toscanelli, the friend and correspondent of Columbus. No wonder Diego Deza, the Dominican confessor of Isabella, faithful to the Albertinian tradition in the Dominican schools, took up the case of Columbus with the queen, about the year 1485. No wonder that Columbus, whose set of Albert's works, annotated in his own handwriting, is still preserved in Seville, found a hearing, sympathy and shelter at St. Stephen's Convent, Salamanca, where the question of an expedition to the Indies was once more agitated after having been shelved for the seven years following the first junta of learned men at Santa Fe in Spain. And only a few months before his death the discoverer wrote to his son Ferdinand, begging him to convey to the gracious queen the information that, but for the goodly offices, interest, and learning of Diego Deza, she would not have been able to add the jewel of the Indies to her crown."

Schwertner further states:

"Albert's curiosity about the physical constitution and conformation of this world extended in all directions and we find him speaking with originality on all phases of cosmography. In establishing the rotundity of the world he speaks in the plainest terms of the Suez Canal as it was built in our own age. Emil Michael sees in his cosmographical doctrine a very clear adumbration of Laplace's theory. As regards the movement of planets, he suggested theories that were put forth later on as practicable and workable. It is no wonder that Albert's influence on Copernicus has often been pointed out. There is still preserved a well-worn set of Albert's works, filled with original notes by that indomitable investigator. His influence on Keppler cannot be denied, and the researches of these two together cleared the way for Newton and his immortal laws. Nor is it unlikely that Newton harked back to Albert, for there are points of view and modes of expression in the great Englishman which sound like echoes of the medieval scientist . . . Alexander Humboldt called attention to the fact that Albert

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had sketched a workable theory of zones in connection with, and growing out of, his treatise on climatology. Better than most of his contemporaries Albert indicated the effects of temperature on flowers, beast, and men. He was far in advance of his age in explaining rain, dew, and snow . . . He stands alone in his day for his vivid and accurate description of volcanic eruptions."

Albert lived to the ripe old age of 87, very busy till almost the last. Intense and prolonged activity, heavy responsibilities, extensive and frequent journeys—evidently none of these things wore him out.

The world of science and learning called him "Albert the Great" even while he lived. As one authority puts it, "Albertus so impressed the brilliant minds of his contemporaries with the unrivalled catholicity of his knowledge that they conferred a doctorate such as no man had ever received—not in one branch of learning or another—but in all." With one consent they proclaimed him, and for all time he remains the Universal Doctor. Another title bestowed on him was "Doctor Expertus" in recognition of his notable scientific experiments and observations.

With all his scholastic and scientific activity Albertus always remained steadfastly and primarily devoted to the things of the soul and the spiritual advancement of the many peoples with whom his frequent travels as student, teacher, churchman and diplomat brought him into contact. Six years ago the Church to which he was so zealously devoted, and which had raised him to a responsible bishopric (Ratisbon) in his sixty-fourth year, solemnly proclaimed this great Dominican friar a canonized saint and conferred upon him the rare three-fold liturgical title of "Bishop, Confessor, and Doctor." His feast day falls annually on November 15.

If he were living today Albertus would be viewed as Nobel prize caliber by the world of Science. The Church views him as a glorious saint in heaven. Hence, we have good reason for calling this man, whose whole life of more than four score years demonstrates the essential, intrinsic harmony between the Church and Science, the scientist-saint or the saintly scientist.

Medicine has its St. Luke; medicine and pharmacy their Saints Cosmas and Damien; dentistry its St. Appolonia; nursing its St. Agatha and St. Alexis. St. Blaise is invoked against throat diseases; St. Vitus against epilepsy; St. Erasmus against intestinal disorders, and other saints against other diseases. But Science as a whole, with its ever-increasing and inescapable ramifications, pure and applied—in the laboratory, in the school, the home, the hospital, the factory, the mine, on the farm, on the land, in the air and on the sea—Science as a whole has no patron saint.

The writer, therefore, humbly suggests the adoption of the wonderful and universal man of science—Albert the Great—as its special patron; and since the scientist Albertus was particularly interested in teaching and in the organization of teaching, the further suggestion is made that it would perhaps be particularly appropriate and fitting if Albert were accepted with especial enthusiasm *by the teachers and students of science*, such as the readers of the *Science Counselor*.

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Atmospheric Electricity

Continued from Page One Hundred and Fifteen

building and a jet of water escapes from the other and breaks up into fine drops in the air at the point, the potential of which is to be measured. The tube and cistern are connected to the needle of a quadrant electrometer, the quadrants of which are kept at equal and opposite potentials by a battery as shown in the diagram, Figure 2. Suppose the insulated system is lower in potential than the air when the jet is started; negative charge is induced on the end of the pipe in the air and a positive charge at the cistern. As the jet continues to flow, negative charge is carried away by the drops until the whole negative charge disappears and the insulated system is at the same potential as the air. The needle of the electrometer changes its position relative to the quadrants as its potential changes; any later change in the earth's field will call forth a corresponding change in the position of the needle. A record of the changing deflection can be made by reflecting light from the electrometer mirror to a moving strip of photographic paper. The wall of the building is at ground potential so that the potential obtained is that of a point at a distance measured horizontally from the building and not vertically from the ground.

(To be continued.)

Amateur Taxidermy

Continued from Page One Hundred and Four

type of connections as before. It is important to cover all the wires with tow or cotton, well tied down. Start building up the body by twisting cotton around the wires and then filling in all the parts according to the right proportions, or if the animal is large, with damp excelsior, which is easier to shape. Start filling in from the neck and work downwards. When the measurements of the specimen agree with those taken before skinning the animal, sew up the opening of the skin.

FINISHING TOUCHES

Take a small board, drill holes for the wires to pass through and mount your specimen in whatever position you desire. When you are filling in the specimen, bend the legs and shape the backbone into the desired positions. After fastening the specimen down, take an awl or a knitting needle and with it work some of the excelsior or cotton into places that you think need more, and remove or press down others that have too much, until you are satisfied that your work imitates nature pretty well. The head is the most difficult part to finish. Cut off the wire if it protrudes through the nose. If you have used clay in the cheeks, press them into the desired shape. If necessary, add bits of cotton until the two cheeks are alike. Be sure to get the two eyes on the same level. Have them look at the same point. Fill the lips, the end of the nose, and the chin with clay. Press the lips together. If necessary, you may pin them in place until they dry. After filling the eye holes with clay, push the glass eyes into place and, with a needle, work the eyelids over them. Fix the ears in the position that you would have them dry. It may be necessary to place the ear between two cardboards which may be clipped together or pinned. Pin each toe in position for drying. Arrange the tail so that it appears natural.

Comb the hair, and set your specimen away to dry. Keep it in a clean place, away from direct sunshine. After two or three weeks of drying, it is ready for the final touches. If, in drying, the mouth opens or the eyes or the lips leave cotton showing, fill in the spaces with putty. Take out all the pins. Dress the hair with a brush.

Where necessary to make them appear natural, touch up the soft parts of the animal with paint. Using equal parts of turpentine, oil and paint, with a sable brush, paint the eyelids, lips and nose with natural tints. With a mixture of equal amounts of varnish and turpentine, touch up the toe-nails. If you are not pleased with your first specimen, do not be discouraged. Take notes on the points that you think you can better in your next attempt. Such notes will help you to make perfect specimens later on.

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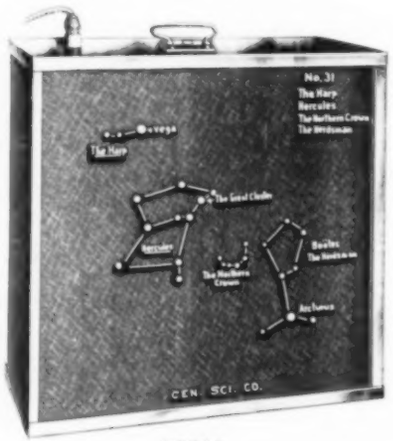

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REFERENCES

1. Turton: *Service Leaflet* No. 41.
2. Hornaday, Wm. T., *Taxidermy*, Scribner's, N. Y., 1929.

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1. Jonas Bros., Denver Colo. Write for *Taxidermists' Supplies*, (Catalog No. 5).
2. John Akhurst, 78 Ashland Place, Brooklyn, N. Y.

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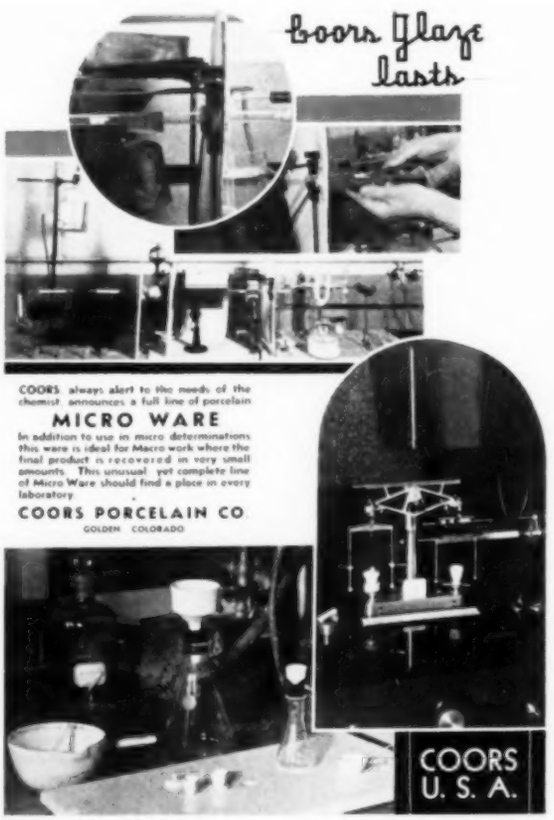
Three Invitations

Continued from Page Ninety-six

What are your troubles? What topics would you like to have considered at the 1938 Round Tables? The discussion of what points would be most interesting to those in attendance?

If you want to make the Conference of greater help to science teachers, send in your list—one topic or a dozen. A postcard will do. Address it to the Director of the Science Conference, Duquesne University, Pittsburgh, Pa. Please send it in early. Now is a good time. The most frequently mentioned topics will be placed on the program. Whether or not you plan to attend the Conference, your suggestions are solicited.

May we have your cooperation?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School of Education
School of Nursing Education
Department of Commercial Education
Reserve Officers Training Corps

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